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# OPERATION & MAINTENANCE HANDBOOK

MODEL 102
PULSE GENERATOR
Part Number 37000-011

INSTRUMENT REGISTRY

MP MASTER
MA28776

SYSTRON-DONNER CORPORATION
DATAPULSE
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## MODEL 102 3 MC PULSE GENERATOR

Model 102 Pulse Generator provides wide versatility in repetition rate, delay, pulse width, amplitude and pulse shape control. Vernier control of pulse is realized through the use of a 1, 2, 5 range switching arrangement. The vernier control fills in from 1 to 2, or from 2 to 5, or from 5 to 10 in a decade switching pattern to give high resolution, but convenient switching.

Regulated power supplies insure low jitter and amplitude stability. Electronic overload protection for the output pulse automatically limits the output pulse amplitude.

This instrument is ideal for the advanced laboratory, and for production line or other testing operations.

This manual contains general and detailed instructions for use and maintenance of your DATAPULSE Model 102 Pulse Generator. A complete understanding of its contents will contribute greatly to full utilization of the broad capabilities of this instrument.

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# SECTION I

# SPECIFICATIONS

## 1.1 REPETITION RATE

Continuously variable from 2 cps to 3 mc covered in 19 steps (1, 2, 5 series) plus uncalibrated vernier. Step accuracy is 10% nominal (15% max.), with vernier at min, stability* is typically ± 1 1/2%, jitter is typically .08%.

## 1.2 EXTERNAL TRIGGER

Standard unit requires 15v pos. pulse with less than 2 μs rise time at 0 to 3 mc, 20v rms sine wave at 200 cps to 1 mc. When specified with Option T, requires pos. pulse of at least 50 ns duration and 5v amplitude (7 volts above 1 mc) with rise time less than 4 ns per volt (or pos. 15v pulse of 20 ns duration). The Sync Output occurs approx. coincident with the leading edge of an external trigger.

## 1.3 SINGLE PULSE

Operation of a front panel pushbutton provides one cycle of output.

## 1.4 MAIN PULSE DELAY (of leading edge from Sync Output)

Continuously variable from approx. 0.2 μs max. to 10 ms, covered in 14 steps (1, 2, 5 series) plus uncalibrated vernier, at least 70% max. duty cycle below 2 mc rep. rate.

## 1.5 MAIN PULSE DURATION

Continuously variable from 50 ns to 10 ms, covered in 14 steps (1, 2, 5 series) plus uncalibrated vernier.

## 1.6 STABILITY, JITTER, ACCURACY (Delay & Duration)

Stability* is typically ± 2 1/2%. Jitter is typically 0.05% + 2 ns. Step control accuracy is ± 10% nominal (15% max. at duty cycles to less than 50%).

## 1.7 MAIN PULSE OUTPUT

Selectable pos., zero, or neg., dc coupled, 50 ohms nominal source impedance.

### 1.7.1 Amplitude

At least 50v peak into 50 ohms (approx. +70v, -125v open circuit). Provides at least 15v into 10 ohms (1.5 amperes peak) at duty cycles to 4%. Stability* is approx. ± 5% max. For pulses up to 3 μs duration, provides at least 100v into 200 ohms when used with Type 2102 impedance matching transformer.

### 1.7.2 Baseline DC Level (With 50 Ohm Load)

Nominally at less than 500 mv (1v max.) on pos. pulse, less than 50 mv (100 mv max.) on neg. pulse, attenuated according to attenuator control setting. See Applications Bulletin 102-4 if other levels are required.

### 1.7.3 Attenuation

Continuously variable zero to 60 db (approx. 10% accuracy), covered in 10-db steps, 2-db steps, and uncalibrated vernier.

### 1.7.4 Waveform (Into 50 Ohm Resistive Load, Measured on Sampling Oscilloscope - See also Applications Bulletin No. 1000-1)

Rise time (leading edge) is continuously variable from nominally 10 ns to 0.5 μs. Fall time (trailing edge) is slightly greater than rise time. Overshoot (less than 15 ns in duration) is less than 4% of nominal amplitude at rise times of 13 ns and greater at less than 30 db attenuation. Top slope may be adjusted to flat within 3% of nominal amplitude at any pulse width up to 1 ms (less than 10% droop at 10 ms). See Applications Bulletin No. 102-11.

### 1.7.5 Duty Cycle and Overload Protection

Average output stage current in excess of 225 ma (approx. 20% duty cycle) automatically operates a panel indicator lamp and activates protection circuits to partially disable output. Removal of overload automatically returns circuit to normal. The unit may be adjusted (internal screwdriver adjustments per Application Bulletin No. 102-1) to provide reduced amplitude output at duty cycles to 70% (50% above 1 mc), generating at least 15v peak into 50 ohms at 50% duty cycle.

## 1.8 SYNC OUTPUT

Pos. 20v pulse from approx. 100 ohms, approx. 0.1 μs duration, ac coupled.

## 1.9 POWER SUPPLIES

All dc power supplies, including output stage plate supply, are fully regulated for stable operation under varying conditions of load or line voltage.

## 1.10 POWER REQUIRED

105-125v, 50/60 cycle, ac, approx. 500 w max. Operation at 220v and 50/60 cycles may be specified at no added cost.

## 1.11 CONSTRUCTION

Brushed aluminum panel with etched black and red markings, beige cabinet with quick-release top and bottom covers, forced air cooling with filter, BNC connectors.

*Stability is stated as typical change with line voltage variation of ± 10v around 115v.

### 1.12 SIZE AND WEIGHT

8 3/4" h x 17" w x 15 1/4" d. May be rack mounted (8 3/4" h x 19" w panel space) by specifying Model 102R or by removing handles and cabinet covers and installing Type 1002 set of rack mounting brackets and dust covers. Weight: 35 lbs.

### 1.13 ACCESSORIES FURNISHED

One operation and maintenance manual, 8 ft. line cord with NEMA 3-prong plug.

### 1.14 ACCESSORIES AVAILABLE

Extra instruction manual copies; 50-ohm power termination (Type 2002); inverting pulse transformer (Type 2101) for external triggering from neg. pulses or providing neg. Sync Output; impedance matching transformer (Type 2102) for generating 100v amplitude pulses; 60 db external attenuator (Type 2450); rack mounting set (Type 1002); UHF and BNC 50-ohm coaxial cables.

# SECTION II

# OPERATING INSTRUCTIONS

## 2.1 DESCRIPTION OF CONTROLS AND CONNECTORS

See Figure 2-1

2.1.1 Power On

Connects or disconnects ac input voltage to transformer primaries within instrument.

2.1.2 Pilot

Indicates when power is applied to instrument.

2.1.3 Repetition Rate

A 20-position switch which sets the values of R and C in the oscillator to determine pulse repetition frequency. One position is provided for external triggering.

2.1.4 Repetition Rate-Vernier

A potentiometer mounted concentric with repetition rate switch provides an uncalibrated fill in control between positions of repetition rate switch.

2.1.5 Single Pulse

A momentary contact push button which initiates one cycle of output, when repetition rate switch is in EXT. position.

2.1.6 Pos. External Trigger Input

BNC connector accepts 20v rms sine wave or +15v pulse with 2 μs rise from zero to 3 mc to externally drive the oscillator when repetition rate switch is in the EXT. position.

2.1.7 Positive Sync Output

BNC connector couples a 20v positive sync pulse which provides a "zero" time reference for the delay circuit.

2.1.8 Pulse Delay

A 14 position switch which sets the values of R and C in the delay circuit to determine pulse delay.

2.1.9 Pulse Delay-Vernier

A potentiometer mounted concentric with pulse delay switch, which provides an uncalibrated fill-in between positions of the pulse delay switch.

2.1.10 Pulse Width

A 14 position switch which sets the values of R and C in the width circuits to determine pulse width.

2.1.11 Pulse Width-Vernier

A potentiometer mounted concentric with pulse width switch, which provides an uncalibrated fill-in between steps of the pulse width switch.

2.1.12 Polarity

A 3-position switch which selects positive, negative or zero output.

2.1.13 Rise Time

A potentionmeter, mounted concentric with the polarity switch, which varies the rise time of the output pulse.

2.1.14 Attenuation (0-10 db)

A 6-position switch which selects 0 to 10 db of attenuation in steps of 2 db.

2.1.15 Attenuator-Vernier (0-10 db)

A potentiometer, mounted concentric with 0-10 db attenuator, which provides an uncalibrated fill-in between steps of the 0-10 db attenuator.

2.1.16 Attenuation (0-50 db)

A 6-position switch which selects 0-50 db of attenuation in steps of 10 db.

2.1.17 Pulse Output Connector

BNC connector couples variable parameter pulse to external load.

2.1.18 Average Pulse Current Overload

Red indicator light indicates when maximum average current limitation has been exceeded and overload protection circuit is in operation.

2.1.19 Fuse (Located on Rear Panel)

A 5-amp, fast blow fuse protects instrument against ac overload.

2.1.20 Power Input (Located on Rear Panel)

3-prong male connector connects instrument to ac line through NEMA 3-wire line cord.

## 2.2 PLACING IN OPERATION

Set pulse repetition rate switch to 1 kc and vernier fully ccw.
Set pulse delay switch to 0.5 μs; vernier cw.
Set pulse width switch to 0.5 μs; vernier cw.
Set polarity switch to "+".
Set rise time control ccw.
Terminate output pulse into 50 ohms.
Set power switch to ON. (Pilot light should indicate that power is on)
Sync oscilloscope from positive sync output with sweep speed at 0.5 μs/cm and vertical sensitivity at 20v/cm.
View output pulse and verify presence of same.
Allow instrument to warm up 1/2 hour before operating.

Figure 2-1. Front Panel Controls.

## 2.3 OPERATING CONSIDERATIONS

### 2.3.1 Single Pulse Operation

Place REPETITION RATE control on EXT. prior to depressing button. Maximum single pulse rate is one per second.

### 2.3.2 External Triggering

REPETITION RATE control must be on EXT. Maximum repetition rate is 3 mc.

### 2.3.3 Delay Duty Cycle

Delay circuits may fail at PULSE DELAY control settings greater than 70% of the main pulse period.

### 2.3.4 Width Duty Cycle

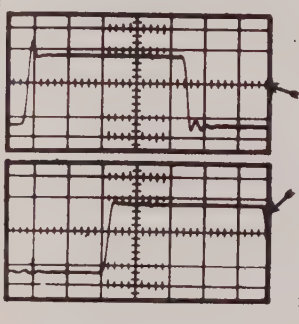
Pulse width circuits may fail at PULSE WIDTH control settings greater than 70% of the main pulse period. Also, any combination of pulse width and PRF which causes delivery of over 300 ma to the external load and/or to the internal attenuator will cause the power supply to current-limit at this level. This condition is signaled by the AVERAGE PULSE CURRENT OVERLOAD indicator. It does not damage the instrument to operate indefinitely in this mode; however, the output pulse amplitude will be markedly unstable.

### 2.3.5 Overshoot

The RISE TIME control may be used to trim out overshoot and optimize waveform.

### 2.3.6 Cooling

The bottom dust cover must be in place to provide adequate cooling. Maintain a clearance of at least three inches at the back of the rear air intake, and be sure to clean the air filter at regular intervals.



From Tektronix 541 with vert. deflection 20v/cm and sweep speed 0.1μs/cm

Figure 2-2. Pos. Pulse Connected to Scope with 4' RG-58A/U, Terminated in 50Ω at Generator.

Figure 2-3. Pos. Pulse where POS. SYNC OUTPUT is Connected to Scope with a Clip Lead. Notice baseline preceding the Pulse.

### 2.3.7 Pulse Top Saturation Oscillations

Because of the limited cathode emission of the output tubes the output pulse amplitude will vary somewhat as a function of pulse width duty cycle. For this reason the top of the pulse may be below, on the threshold, or well into the saturation region of the output tubes as a function of duty cycle.

When the pulse top is at the saturation threshold it is unstable and oscillations occur. Turning in about 1/2 db of attenuation on the ATTENUATION VERNIER will suppress this effect.

### 2.3.8 Cabling Considerations

Delivery of clean waveforms can be assured if good cabling practices are observed. The sync pulse should be connected to the scope and/or the system under test with 93 ohm coaxial cable. This line should be terminated into 93 ohms at the scope. The main pulse should be connected to the load via a 50 ohm coaxial cable and terminated into 50 ohms at the load.

### 2.3.9 Amplitude Controls

When the polarity of the main pulse output is negative, amplitude ranges may not overlap and may be separated by several volts. The gap is widest between the two highest ranges when the duty cycle is maximum, and narrows in proportion to amplitude attenuation and duty cycle reduction. No gaps occur when the polarity of the main output is positive.

## 2.4 SPECIAL APPLICATIONS

### 2.4.1 Positive Sync Pulse Output Polarity Inversion

Some applications require negative polarity sync pulses which are not normally available in the Model 102. DATAPULSE Model 2101 Trigger Pulse Inverting Transformer, available as an accessory was designed to permit inversion of sync pulses.

### 2.4.2 Negative Pulse External Triggering

DATAPULSE Model 2101 Trigger Pulse Inverting Transformer, discussed above, may also be used to invert negative trigger pulses which may then be applied to the POS. EXTERNAL TRIGGER INPUT of the Model 102.

### 2.4.3 Further Applications

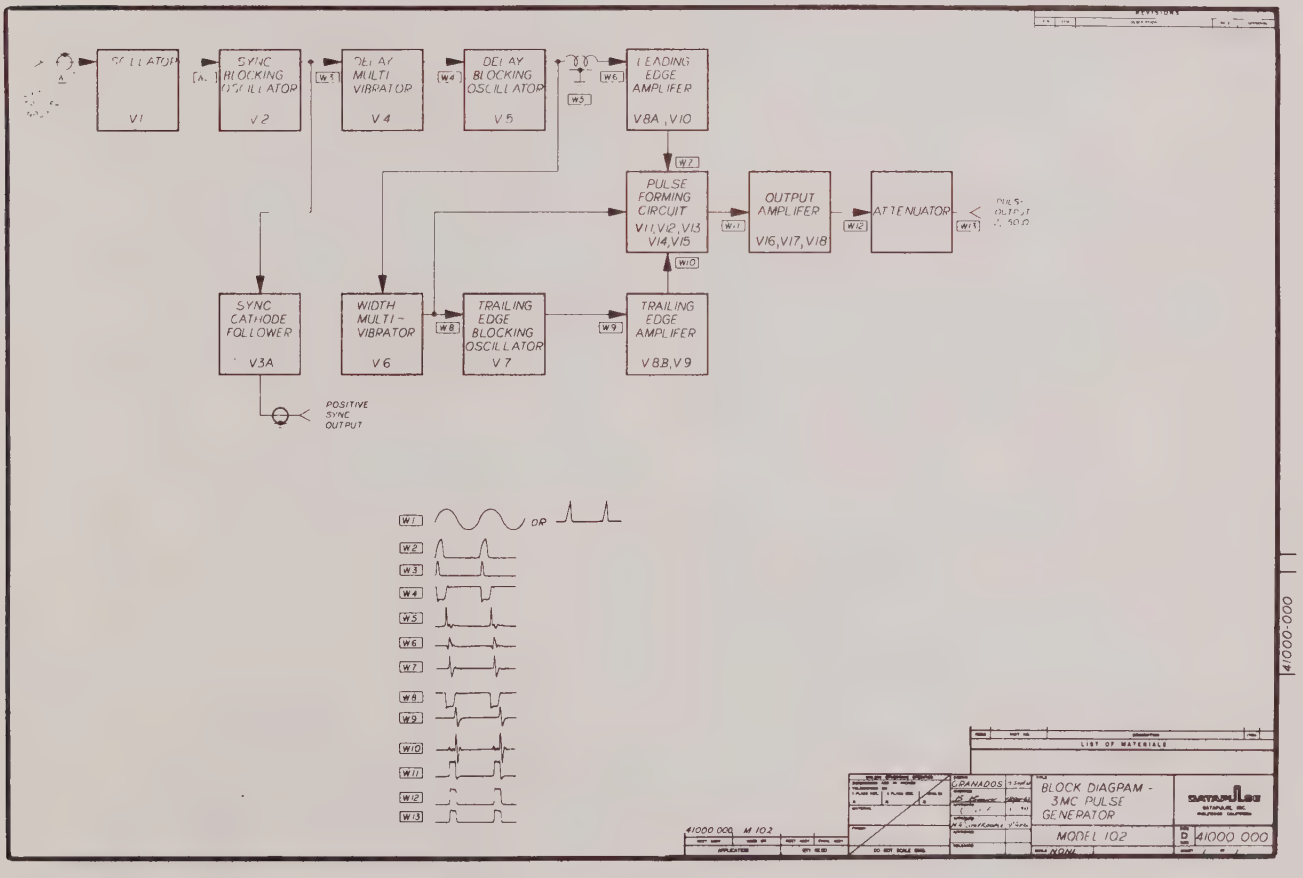
For further applications and service information, refer to the Application & Services Bulletin in the rear of this manual.

# SECTION III

# THEORY OF OPERATION

## 3.1 BLOCK DIAGRAM DESCRIPTION

A pulse repetition rate (W2) variable between 2 cps and 3 mc is determined by either the internal oscillator or an external drive. The output of the Oscillator (W1) is used to trigger the Sync Blocking Oscillator which provides a "Zero" time reference pulse (W3). This pulse is coupled-out (in the Sync Cathode Follower) as a sync pulse and is used to trigger the Delay Multivibrator. The gate from this MV is differentiated and the trailing edge portion is used to trigger the Delay Blocking Oscillator. The output from the Delay BO (W5) is used to trigger the Width MV and is also delayed (0.09 μs) to become the leading edge trigger (W6) which is amplified by the Leading Edge Amplifier. The width gate (W8) is differentiated and used to trigger the Trailing Edge BO, which is amplified by the Trailing Edge Amplifier. Using the leading and trailing edge triggers (W7) and (W10) in conjunction with the duration gate (W8), a fast rise and fall pulse is formed. This pulse (W11) is cathode-follower coupled to the output amplifiers where it is transformed into a heavy current pulse (W12) which is applied to the attenuator and attenuated to the level desired to give the output pulse (W13).



### 3.2 ASTABLE SCHMITT TRIGGER

The Astable Schmitt trigger circuit differs from a normal Schmitt trigger in that the changing network $C_t$ and $R_t$ (see Figure 3-1) produces a controlled positive going waveform on the grid (pin 2) of the trigger tube. This circuit functions as follows: V1B conducts heavily because of the bias imposed upon it by R6, R7, and R10 between B+ and B-. The current of V1B flows through $R_k$ causing a large voltage drop which appears as a positive potential at the common cathode pins 3 and 8. As the grid (pin 2) of V1A is around ground, V1A is cut off by the positive potential at its cathode (pin 3). At a time (t), $C_t$ begins to charge through $R_t$ toward B+. This charge continues until time (t2) when the grid-to-cathode-voltage of V1A is small enough to allow conduction. As V1A conducts, its plate (pin 1) dips sharply because of current flowing through R6 (15k). This negative going potential is coupled across R7 (22k) and C3 (27 μμf) to the grid of V1B (pin 7). The conduction of V1B now decreases, decreasing the cathode potential of V1A causing V1A to conduct harder and thus regeneratively saturate itself and cut off V1B.

Because R6 is 15k and R8 only 1k, much less current flows through $R_k$ as V1B cuts off and its cathode potential approaches ground. The grid of V1A (pin 2) follows the cathode down, discharging $C_t$ through grid current. At a time (t3), a point around ground is reached where the cathode to grid potential is low enough for V1B to conduct. An attendant increase of current through Rk causes a higher potential at the cathode of V1A (pin 3). As V1A decreases conduction and its plate (pin 1) becomes more positive, this waveform coupled across R7 and C3 to the grid of V1B (pin 7) causes V1B to conduct harder with an attendant increase of current through $R_k$ which regeneratively saturates V1B and cuts off V1A. $C_t$ now begins to charge through $R_t$ toward B+ and the cycle is repeated.

The output of this circuit is taken from the plate of V1B (pin 6) and is used to trigger the Sync Blocking Oscillator (V2).

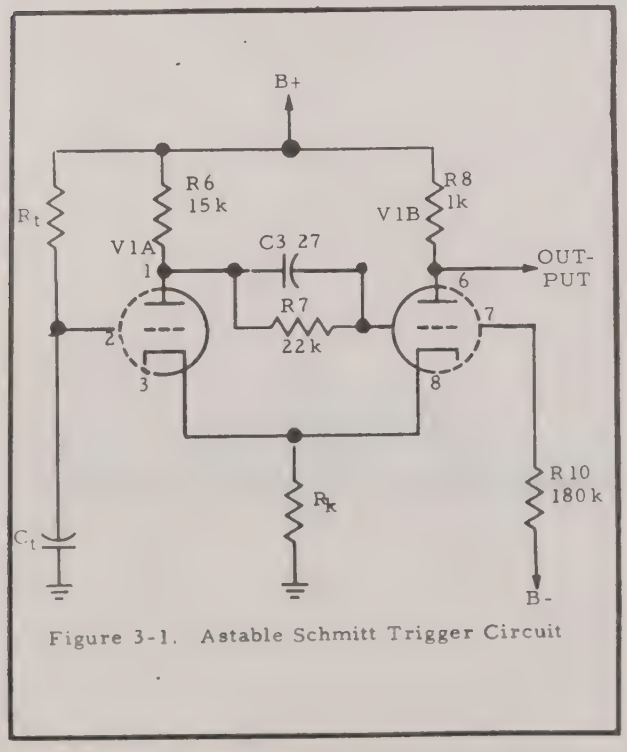



Figure 3-1. Astable Schmitt Trigger Circuit

### 3.3 BLOCKING OSCILLATOR

The Sync Blocking oscillator is typical of the Delay BO and Trailing Edge BO (see Figure 3-2) and operates as follows:

Initially both sides of the tube are cut off because of grid bias returns.

When a positive pulse arrives at the grid (pin 2) of the left-hand section, conduction is initiated driving both plates negative. Due to the polarity of the transformer a negative pulse upon the plates appears as a positive pulse upon the grid (pin 7) of the right-hand side of the tube causing this tube to conduct. This added current drives the plate more negative which in turn reinforces the signal at the grid until the plate (pin 6) of the right-hand section is driven into saturation. At this point the gain from grid to plate becomes less than one and the process reverses itself driving the tube into cut off which completes the cycle. The output of this circuit is taken off the cathode (pin 8) of the right-hand side across $R_k$.

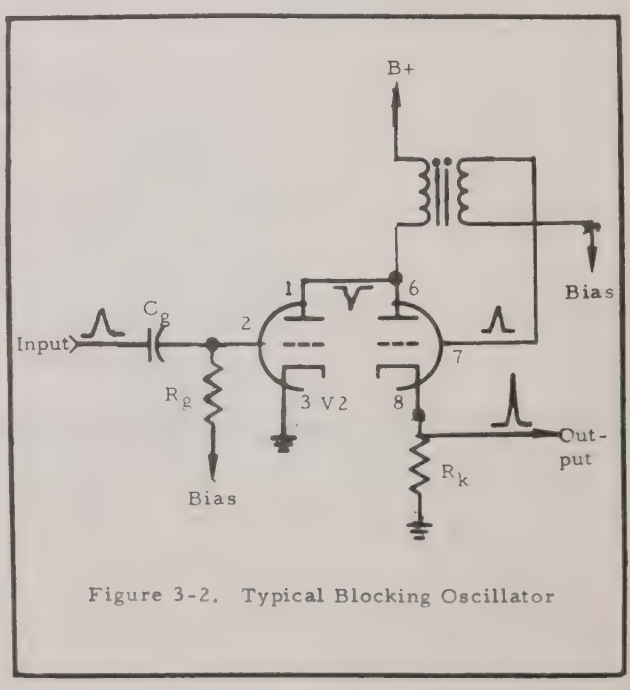



Figure 3-2. Typical Blocking Oscillator

### 3.4 THE ONE-SHOT MULTIVIBRATOR

Pulse delay circuitry is a cathode coupled one shot multivibrator (see Figure 3-3). Since pulse width generation is essentially a delay function, (i.e., the delay of trailing edge with respect to leading edge) the same technique is used to perform both operations. For this reason only delay shall be discussed.

In the quiescent state, V4B is cut off because of the bias imposed upon its grid (pin 7) by the voltage divider composed of R19, R20, R25 and R28. V4A is conducting because of its positive grid return through Rt. As the plate load R19 is great (100k with respect to $R_k$, the common cathodes of V4A and V4B are at a potential around ground. At time (t0) a positive input trigger causes V4B to conduct and because of the low impedance (470) in the plate of V4B (pin 6) a large current flows through $R_k$ causing the cathode of V4A (pin 3) to become sufficiently positive to cut off V4A. As the plate (pin 1) of V4A becomes more positive, because of decreased current flow, this waveform is coupled across C9-R20 and C11-R25 to the grid of V4B causing more current to flow, regeneratively saturating V4B. As soon as the cathode of V4A (pin 3) becomes more positive than its grid (pin 2) $C_t$ begins to charge through R5. This charge continues until a point is reached at time (t2) when the grid of V4A (pin 2) is sufficiently positive to allow V2B to again conduct driving its plate (pin 1) negative. This negative waveform coupled across C9-R20 and C11-R25 to the grid of V4B (pin 7) causes conduction of V4B to decrease, forcing the cathode of V4A less positive and increasing conduction, regeneratively saturating V4A and cutting off V4B. The cathodes of V4A and V4B return to their quiescent state and the grid of V4A follows the cathodes down as grid current discharges $C_t$ completing the cycle.

The trailing edge of the negative gate at the plate of V4B (pin 6) is differentiated and used to trigger the delay blocking oscillator. In the case of pulse width, this gate becomes the duration gate.

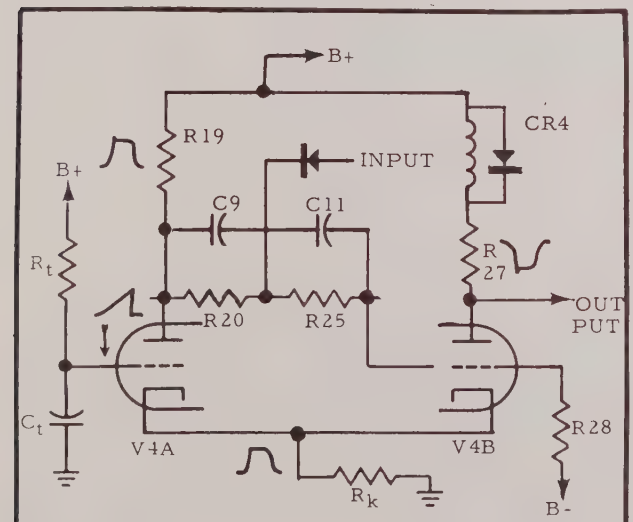


Figure 3-3. Cathode Coupled One-Shot Multivibrator

### 3.5 TRANSFORMER COUPLED AMPLIFIER

Initially the tube is cut off because of bias return. As a positive pulse is applied to the grid, the plate conducts heavily and goes negative. The polarity of the transformer is such that a negative charge upon the plate provides a positive going signal to the grid of the next tube. $R_p$ is used to damp the secondary of the transformer to prevent oscillations. Pulse narrowing takes place (see Figure 3-4) as each preceding tube only conducts as the pulse is above the cutoff point thus eliminating the time from base line to approximately 85% amplitude point.

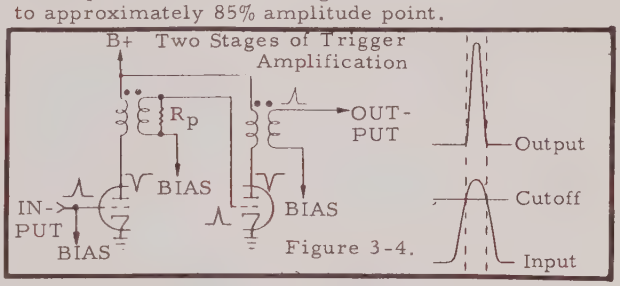


Figure 3-4.

### 3.6 PULSE FORMING CIRCUITS

V14 is normally conducting because of its positive grid return (see Figure 3-5). Its plate (pin 5) sets slightly above ground. The negative duration gate applied at its grid (pin 1) cuts off V14 and its plate starts to rise at a rate governed by circuit capacity. A few nanoseconds later the leading edge trigger is applied to the "lift up diode" (V13) whose low impedance charges the capacitor rapidly causing a fast rise leading edge. The top of the pulse remains at the voltage set by the top slope control as V14 is still held off by the duration gate for the duration of the pulse. The fast rise pulse is applied to the grid (pin 2 and 7) of the cathode follower (V15), whose output drives the output amplifier section. At the end of pulse time, the gate at the grid of V14 subsides and V14 begins to conduct. Simultaneously the positive trailing edge trigger is applied to the grids (pin 2 & 7) of the trailing edge pull-down tube V12 driving its plate sharply negative discharging circuit capacity and creating a fast fall trailing edge. This fast rise and fall positive pulse is then applied to the output amplifier section. The capacitors C34 (overshoot) and C39 will provide a feedback network to trim pulse irregularities.

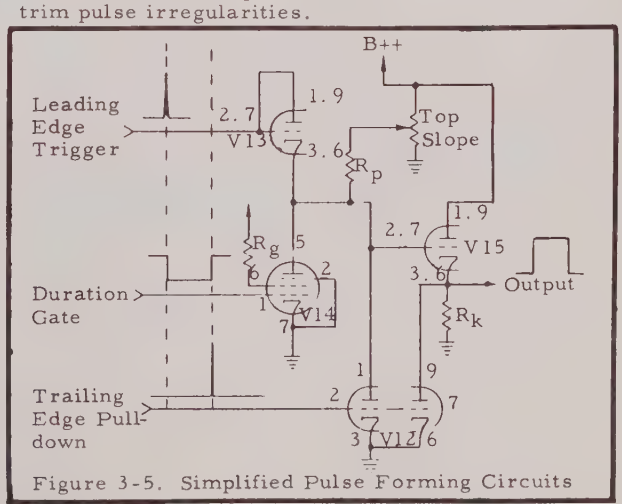


Figure 3-5. Simplified Pulse Forming Circuits

### 3.7 OUTPUT AMPLIFIER

The fast rise and fall pulse from V15 is coupled across C40 to the rise time control R64. Since no commutation is provided, an increase in the resistance of R64 will cause rise time to be increased in an exponential manner because of the input capacity of the output tubes V17 and V18. The output tubes are connected such that, through boot strappings, the screen to cathode voltage and hence screen to control grid voltage remains relatively constant with resultant increase in gm yielding a greater degree of wave shape preservation from input to output.

Positive output pulses are obtained from cathode followers with baseline around ground potential. As polarity is changed to negative, the output tube configuration is changed to operate the output tubes as amplifiers, with output taken at the plate. In addition, the ground reference for the power supply is switched such that the baseline remains around ground.

Bias is provided through a cathode follower whose low impedance discharges C40 effectively to prevent a bias shift with changes in duty cycle.

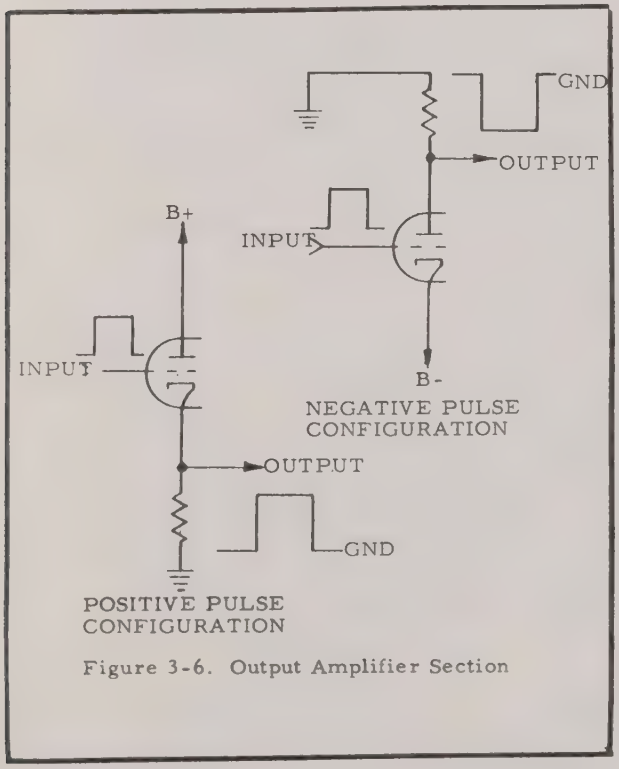



Figure 3-6. Output Amplifier Section

### 3.8 OVERLOAD PROTECTION CIRCUIT

An overload protection circuit is employed to insure that output current does not exceed a safe value. In the event that this limitation is inadvertently exceeded by control settings, a red warning light glows to indicate that this circuit is in operation.

Output current is sampled through R102 and T2 located in the center tap of the output voltage transformer winding. This sample is rectified by CR9 and filtered by the integrating action of V24A and appears as a dc voltage upon the control grid of V24A as current rises to a point predetermined by the setting of R135. V24A will conduct heavily enough to drop the voltage at its plate (pin 1) appreciably. This negative potential is coupled through R140 to the grid (pin 9) of V22A causing V22A to cutoff. The plate (pin 1) of V22A then rises causing a rise at the control grid (pin 2) of V22B. V22B now conducts heavily pulling down the grid of the +225 supply limiting the output of the +225 supply to approximately 150v. This lowered supply to the pulse forming circuit causes sufficient reduction of the amplitude of the output pulse to hold output current at a safe value. The plate of V24A is also coupled to the grid of V3B. As the plate of V24A drops, the grid of V3B drops cutting off V3B. Connected in parallel with V3B is an (overloading indicator) which lights as the plate of V3B goes sufficiently positive.

By setting R136, the indicator is caused to light slightly before the +225 volt supply is reduced.

Note, that as the gain of the servo loop is greater than one, the output voltage may "cycle" somewhat as the circuit is in operation. Because of this the instrument should not be operated in overload condition as erroneous readings will result.

As duty cycle is reduced and output current decreases, the circuit settles back to quiescent state and normal operation ensues.

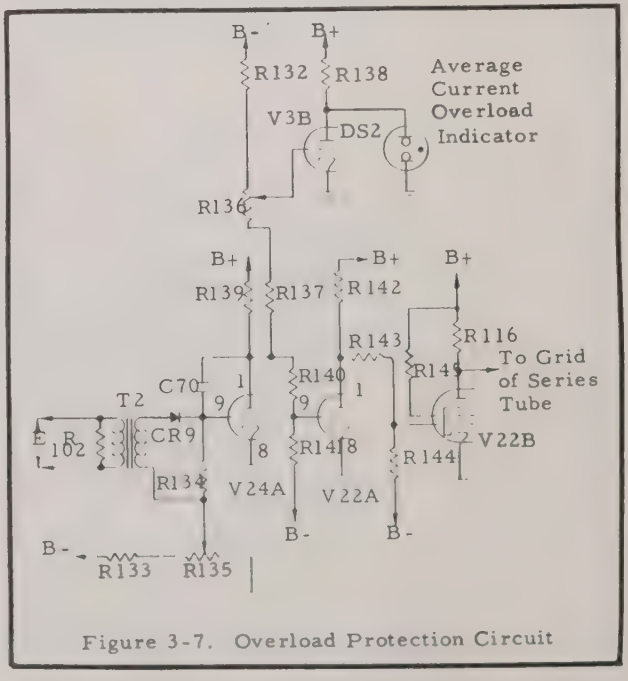



Figure 3-7. Overload Protection Circuit

# SECTION IV

# MAINTENANCE INSTRUCTIONS

## 4.1 PREVENTIVE MAINTENANCE

### 4.1.1 Preventive Inspection and Service

Regular inspection and service of a preventive nature will result in optimum performance and longer life of this instrument. Dust covers should be removed at regularly scheduled intervals to permit inspection for dust, tarnish, corrosion, loose nuts and bolts (especially those serving as electrical conductors), loose cables and fuses, charred insulation, scorched resistors and broken wiring. Discoloration of the printed circuit board, due to heat, does not affect the board's electrical properties and may be disregarded in most cases. This problem may be alleviated if the air filters are cleaned frequently and thoroughly as described below.

### 4.1.2 Filter Cleaning

The instrument is cooled by air drawn into the interior through a washable aluminum-mesh, adhesive coated filter. When dirty, the filter will restrict the flow of cooling air and cause overheating. To clean the filter, first rap it gently on a hard surface to remove loose dirt. Then wash the filter with hot water and soap. DO NOT USE CAUSTICS. After rinsing and drying, dip or spray the filter with an approved adhesive, such as FILTER-COAT manufactured by the Research Products Corporation of Madison, Wisconsin.

### 4.1.3 Fan Motor Lubrication

The fan motor should be lubricated at regular intervals with a few drops of light machine oil.

### 4.1.4 Minor Repairs

The operator should be thoroughly acquainted with the instrument's circuit theory and component location before attempting repair. In all cases, setting and adjustment of controls should be checked in order to verify that difficulties encountered are actually caused by malfunction and not by operation outside of specifications. Check tubes and transistors in suspected circuits prior to conducting extensive tests on other components. A check of the important waveforms brought out to the front panel will be of great assistance.

### 4.1.5 Recalibration

This instrument was designed to provide maximum reliability and stability. To insure that accuracy remains within stated limits, we suggest that calibration be checked after every 200 hours of operation. If the unit is used intermittently, calibration should be checked every three months. Complete instructions for calibration are given in this manual.

## 4.2 PARTS REMOVAL AND REPLACEMENT

### 4.2.1 General

This instrument is sturdily built and easily accessible. Removal of most parts is so simple that explanations are unnecessary. However, some parts are more easily removed if a definite procedure is followed. Replacement of some parts will also require partial recalibration. Refer to Section 4.3 of this manual for calibration instructions.

### 4.2.2 Replacement of Switches

The output amplifier switches may be ordered from DATAPULSE as single sections or as unwired assemblies. If a single wafer on the oscillator, delay, or width switch is defective, the entire switch must be replaced. These are available from our factory either wired or unwired.

The capacitors mounted to these switches are matched sets. Should a capacitor require replacing, its entire set (as indicated on the schematic) must be replaced with a new matched set. These matched condenser sets are available from DATAPULSE. Recalibration is required if the switches or the condenser are replaced.

### 4.2.3 Replacing Tubes

Tubes should not be replaced unless they are actually causing trouble. Unnecessary replacement only necessitates recalibration. Tubes removed for maintenance reasons should be returned to the socket from which they were removed unless found to be defective. When replacement is necessary, only high quality tubes should be used.

### 4.2.4 Soldering Considerations

Although printed wiring is quite vulnerable to heat excesses, a great deal of resoldering can be done on a single joint if care is taken. A 35 watt wedge tip or pointed tip iron and 60-40 rosin core solder are quite effective. Where both sides of the board are accessible apply the tip of the iron (on the side opposite the component) directly to the solder fillet and pull gently on the pigtail with pliers from the opposite side. Where both sides of the circuit board are not accessible, the component lead will be fed through the board through an eyelet. Apply the iron tip to the eyelet and pull the pigtail out with the pliers. To insert a new component, clean out the hole with a sharp object (it may be necessary to apply more heat) and insert the new component, soldering in the old place.

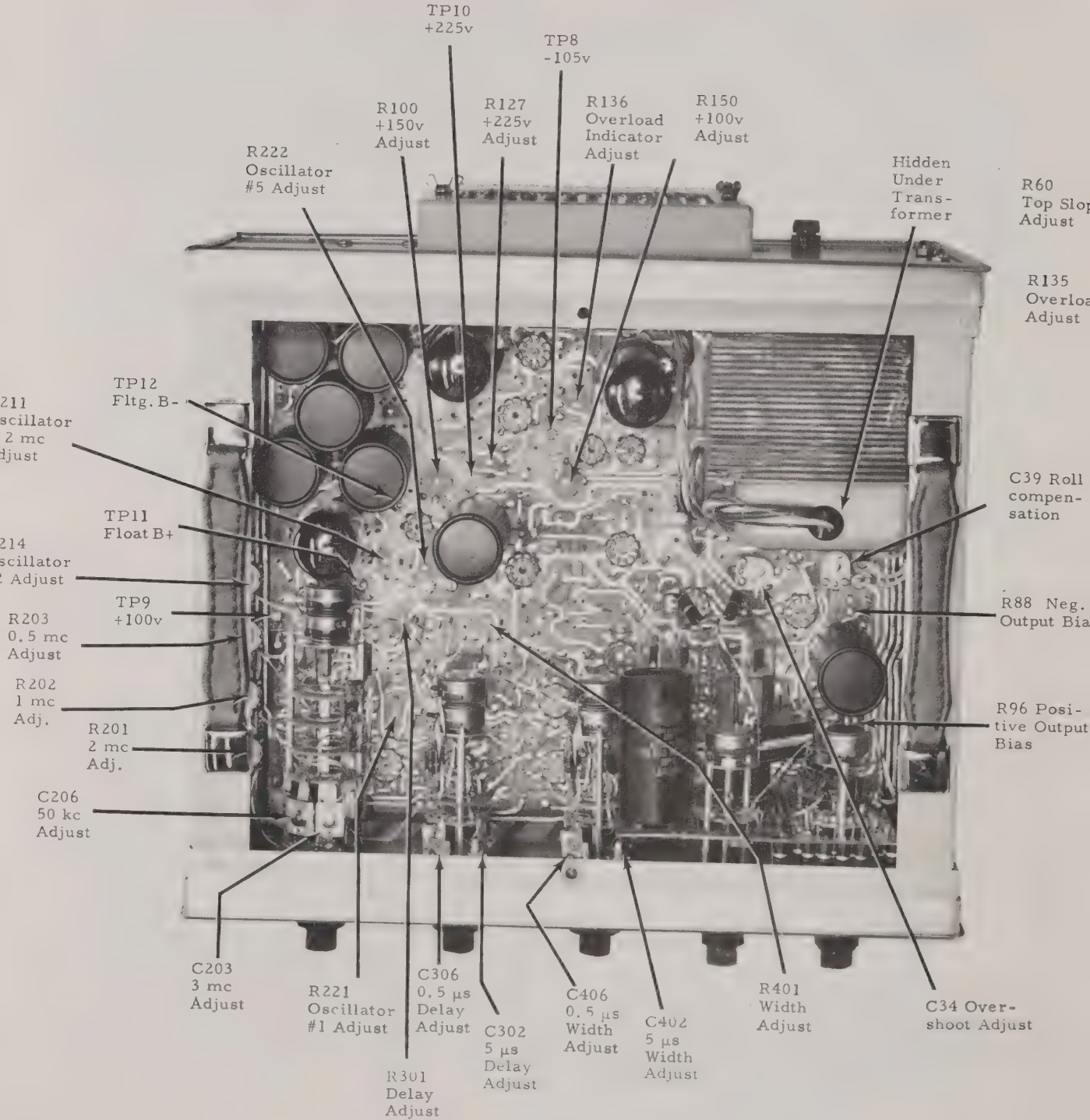



FIGURE 4-1. MODEL 102 VOLTAGE
TEST POINTS AND CALIBRATION ADJUSTMENTS

## 4.3 CALIBRATION PROCEDURE

Prior to attempting calibration, check control settings, check for proper operation and allow the instrument to warm-up for 1/2 hour. Assemble the following.

a. A general purpose 30 mc oscilloscope (TEKTRONIX 543 or equivalent including type "L" high gain preamplifier and Type "N" sampling plug-in or equivalent.)

b. A dc voltmeter (SIMPSON 260 or equivalent). (If overload circuit is to be calibrated, two will be required.)

c. An insulated low capacity screwdriver.

d. A variable ac source (POWERSTAT Model 116 or equivalent).

e. A 50-ohm external termination (DATAPULSE Model 1002 or equivalent).

f. A 500 kc signal generator (HEWLETT-PACKARD 233A or equivalent).

g. If overload circuit is to be calibrated, a tube socket adapter (VECTOR T80C) will be required.

### 4.3.1 Power Supply Calibration

NOTE:

As the timing circuits are dependent upon the regulated power supply voltages for reference, any variance of these voltages will necessarily cause a change in calibration accuracy. Therefore, these adjustments should not be attempted unless one is prepared to carry out complete recalibration.

If power supply voltages are found to vary considerably from specified voltage, temporary readjustment may be made; however, bear in mind that measurements made may not be accurate until the instrument has been recalibrated. If any portion of the instrument fails to calibrate, repair should be effected before attempting to complete calibration.

#### 4.3.1.1 -105v (B-) Supply

This voltage is determined within approximately ± 10% of -105v and regulated by a gas tube (OB2) and no adjustment is provided. This voltage is used as a reference for the +100v and the +225v power supplies and should, therefore, be checked prior to adjustment of these supplies.

Connect a dc voltmeter from tp8 (-105v) to ground. Vary line voltage with variac ± 10% from 115v ac and verify regulation.

#### 4.3.1.2 +110v (B+) Supply

a. Connect dc voltmeter from tp9 (+110v) to ground. Adjust R130 (+100v adjust) for a reading of 110v.

b. Vary line voltage ± 10% around 115v and observe that power supply variation is less than ± 2v.

c. Remove voltmeter and connect a high gain oscilloscope from tp9 to ground. Observe that ripple is approximately 50 mv with pulse repetition rate switch on EXT.*

#### 4.3.1.3 +225v Supply

a. Connect dc voltmeter from TP10 (225v) to ground. Adjust R127 (+225v adjust) for a reading of 225v.

b. Vary line voltage ± 10% around 115v and observe that power supply variation is less than ± 5v.

c. Remove voltmeter and connect a high gain oscilloscope from TP10 to ground. Observe that ripple is approximately 50 mv with pulse repetition rate switch on EXT.*

#### 4.3.1.4 +150 (Floating) Supply

a. Set pulse REPETITION RATE switch on EXT. Set POLARITY switch in "+" position.

b. Connect dc voltmeter from TP11 to ground and adjust R100 (+150v adjust) for a reading of 150v.

c. Vary line voltage ± 10% around 115v and observe that power supply variation is less than ±5v.

d. Remove voltmeter and connect a high gain oscilloscope from TP11 to ground. Observe that ripple is approximately 50 mv.*

#### 4.3.1.5 Bias

a. Place dc voltmeter from junction of CR22 and C54 to ground. Reading should be -18v, +30%-0%.

b. Place dc voltmeter from junction of R110 and R111 to ground. See that reading is between 5.1 and 6.2v. Vary line voltage ± 10% around 115v. See that reading does not vary more than 1%.

*NOTE: This is not a specification, but merely a check on power supply performance and should be compared with previous checks only. Ripple increases over previous readings are a sign that the 6AS7 series tube is weak.

4.3.2 Repetition Rate Calibration

NOTE:

As calibration accuracy on most oscilloscopes is in the range of ±5%, the ultimate calibration accuracy of the instrument is limited by this value, i.e.; if the instrument is calibrated using an oscilloscope which is 5% off in one direction and is then checked with another which is 5% off in the opposite direction, a 10% deviation will be shown. If calibration is performed using a frequency meter type of counter such as Hewlett-Packard Model 5243, driving the counter with the sync pulse, calibration accuracies of ±5% from 2 cps to 100 kc and ±1% above 100 kc can usually be obtained. However, if output is then viewed on a ±5% oscilloscope, these accuracies may then be viewed as ±10% and ±6% respectively.

a. Set REPETITION RATE control to 2 kc, vernier fully ccw.
Set PULSE DELAY control to 0.5 microsec, vernier fully ccw.
Set PULSE WIDTH control to 0.5 microsec, vernier fully cw.
Set POLARITY to "+", attenuator controls fully cw, rise time fully ccw, terminate pulse output into 50 ohm load (DP Part No. 1002).

b. View output pulse on calibrated sweep oscilloscope.

c. Adjust R214, "2" adjust for 0.5 millisecond pulse spacing (2kc/s).

d. Set REPETITION RATE control to 5 kc. Adjust R222, "5" adjust for a pulse spacing of 0.2 millisecond (5kc/s).

e. Set REPETITION RATE control to 10 kc. Adjust R221, "10" adjust for a pulse spacing of 0.1 millisecond (10 kc/s).

f. Check all ranges from 2 cps to 10 kc/s and insure that they are within ± 10%.

g. Set REPETITION RATE control for 50 kc. Adjust C206, 50 kc adjust for a pulse spacing of 20 microsec, (50 kc/s). Check 20 kc/s and 0.1 mc ranges and insure that they are within ± 10%.

h. Set PULSE WIDTH VERNIER fully ccw. Set REPETITION RATE control to 2 mc, VERNIER fully cw. Adjust C203, 3 mc adjust for a pulse spacing of 0.33 μs (3 mc).

i. Set VERNIER fully ccw. Adjust R201, 2 mc adjust for a pulse spacing of 0.5 μs (2mc).

j. Set REPETITION RATE control to 0.2 mc adjust for a pulse spacing of 5 μs (0.2 mc).

k. Set REPETITION RATE control to 0.5 mc. Adjust R203, 0.5 mc adjust for a pulse spacing of 2 μs (0.5 mc).

l. Set REPETITION RATE control to 1 mc. Adjust R202, 1 mc adjust for a pulse spacing of 1 μs (1 mc).

4.3.3 Pulse Delay Calibration

a. Pulse spacing $\left[\frac{1}{\text{Repetition Rate}}\right]$ should be at least 10 times pulse delay at all times.

b. Set REPETITION RATE switch to 200 cps. VERNIER fully ccw. Set PULSE DELAY switch to 0.5 ms; VERNIER fully cw. Set PULSE WIDTH to 0.5 microsec; VERNIER fully cw. Set POLARITY to "+" ATTENUATOR fully cw. View output pulse terminated into 50 ohm.

c. Set R301 (delay adj) for pulse delay of 0.5 ms.

d. Check ranges from 20 microsec to 10 ms and insure that they are within ± 10%. (It may be necessary to change the setting of R301 somewhat.)

e. Set PULSE DELAY switch to 5 microsec.

f. Set C302 for 5 microsec pulse delay.

g. Check 10 microsec and 2 microsec ranges and insure that they are within ± 10%.

h. Set PULSE DELAY switch to 0.5 microsec.

i. Set C306 for 0.5 microsec pulse delay.

j. Check 1 microsec range and insure that it is within ± 10%.

4.3.4 Pulse Width Calibration

a. Pulse spacing $\left[\frac{1}{\text{Repetition Rate}}\right]$ should be at least 10 times pulse width.

b. Set REPETITION RATE switch to 200 cps, VERNIER ccw.
Set PULSE DELAY switch to 0.5 microsec, VERNIER fully cw.
Set PULSE WIDTH switch to 0.5 ms, VERNIER fully cw.
Set POLARITY to "+", ATTENUATOR fully cw.
View output pulse terminated into 50 ohm.

c. Set R401 (width adj) for a pulse width of 0.5 ms.

d. Check ranges from 20 microsec to 10 ms and insure that they are within ± 10%. (It may be necessary to change the setting of R401 slightly.)

e. Set PULSE WIDTH switch to 5 microsec.

f. Set C402 for a pulse width of 5 microsec.

g. Check 10 microsec and 2 microsec ranges and insure that they are within ± 10%.

h. Set PULSE WIDTH switch to 0.5 microsec.

i. Set C406 for a pulse width of 0.5 microsec.

j. Check 1 microsec range and insure that it is within ± 10%.

4.3.5 Output Waveform

Because the rise of the output waveform is faster than the rated response of most general purpose (30 mc) oscilloscopes, exact observation and rise time measurements may not be made without resorting to either a sampling oscilloscope or traveling wave oscilloscope. Viewing directly on the deflection plates of a slower scope may be used, but it must be kept in mind that there is generally considerable inductance in the deflection plate adapter and the slower sweep speed (20 ns/cm) makes resolution difficult. A general purpose oscilloscope is sufficient for "rough" trimming of output waveform and making top slope adjustment for wide pulses.

a. Set REPETITION RATE control to EXT, VERNIER fully ccw.
Set PULSE DELAY to 0.5 microsec, VERNIER fully cw.
Set PULSE WIDTH to 1 ms, VERNIER fully cw.
Set POLARITY to "+", attenuators for 0 db.
Terminate output pulse into 50-ohm load.
Observe output on 0.5v/cm vertical scale.

b. Set (R90) (Pos Bias) for a base line $\leq$ 0.5v above ground.

c. Set POLARITY control to "-", adjust R88 (Neg Bias) for a base line $\leq$ 5 mv below ground.

d. Set POLARITY control to "+".
Set REPETITION RATE to 0.1 kc.
Set RISE TIME fully ccw.
Adjust R60 (top slope) for min. top slope.
Adjust C39 (roll) for min. top slope following leading edge approximately 5 microsec.

e. Set pulse width to 1 microsec.
Set REPETITION RATE to 10 kc.
Adjust C34 (overshoot) for squarest leading edge with minimum overshoot.

f. Repeat steps 4 and 5 until further adjustment is unnecessary.

g. Fine adjustment of C34 (overshoot) and R88, R90 (output bias) may be made on fast response oscilloscope. Rise time control may be turned slightly cw to help trim any ringing on leading edge. At this point check that both rise and decay times are $\leq$ 10 ns.

h. Because of the wide variation of all controls some combinations of settings may be found that will cause slight oscillations on the flat top. Slight alteration of any control will usually eliminate this condition.

4.3.6 Duty Cycle Overload

**WARNING**

THIS ADJUSTMENT IS MADE AND SEALED AT THE FACTORY. ANY ALTERATION OF THIS ADJUSTMENT WILL RESULT IN THE LOSS OF WARRANTY AND MAY RESULT IN SERIOUS DAMAGE TO THE INSTRUMENT.

a. Remove V27. With an adapter such as Vector T80C, reinsert V27 with an ammeter in the plate circuit. (Note: the two halves of V27 are paralleled. Care must be taken that both halves are connected through the ammeter.) Connect a dc voltmeter from the +225v test point (TP10) to ground.

b. Set pulse REPETITION RATE control to 10 kc, VERNIER mid scale.
Set PULSE DELAY to 0.5 microsec.
Set PULSE WIDTH to 20 microsec, VERNIER fully ccw.
Set POLARITY to "+", ATTENUATION to 0 db.
Terminate output pulse into 50 ohm.
Energize instrument.

c. Slowly turn PULSE WIDTH VERNIER cw until an ammeter reading of 225 ma is attained.

Adjust R135 (overload adjust) until +225v supply just begins to drop.

d. Turn PULSE WIDTH VERNIER fully cw and insure that ammeter reading does not exceed 240 ma.

e. Turn PULSE WIDTH VERNIER ccw until ammeter reads 220 ma. Note that +225v supply has returned to +225v. Adjust R136 (overload indicator) until average pulse current overload lamp on front panel lights.

f. Turn PULSE WIDTH VERNIER fully ccw. Note that average pulse current overload lamp extinguishes.

g. Turn PULSE WIDTH VERNIER slowly cw. Note that average pulse current overload lamp lights at 220 ma and +225v supply drops at 225 ma. Also note that 240 ma is not exceeded as pulse width vernier is turned fully cw. If these conditions are not met, repeat steps 3 to 7.

## 4.4 SPECIFICATIONS VERIFICATION

A 1/2 hour warm-up period is required before tests are made. Assemble the following or equivalent equipment:

a. 30-mc oscilloscope (TEKTRONIX 543 and sampling pre-amplifier).

b. Two each dc voltmeter (SIMPSON 260).

c. Tube socket adapter (VECTOR T80C).

d. 50-ohm termination (DATAPULSE Model 1002).

e. 500 kc Signal Generator (HEWLETT-PACKARD).

4.4.1 Power Supply (Repetition Rate Switch on EXT)

4.4.1.1 -105v Supply

Verify that the voltage from TP8 to ground is -105v ± 10%.

4.4.1.2 +110v Supply

Verify that the voltage from TP9 to ground is +110v ±10%.

4.4.1.3 +225v Supply

Verify that the voltage from TP10 to ground is +225v ± 10%.

4.4.1.4 +150v (Variable Reference) Supply

With polarity switch in "+" position, verify that the voltage from TP11 to ground is +150v ± 10%.

4.4.1.5 Bias Supply

Verify that the voltage from junction of C54 and R110 to ground is -18v, +30%-0%.

Verify that the voltage from junction of R110 & R111 to ground is between -5.1 and -6.2.

4.4.2 Repetition Rate

Set PULSE DELAY to 0.5 microsec, VERNIER fully cw.
Set PULSE WIDTH to 0.5 microsec, VERNIER fully ccw.
Set POLARITY to "+", RISE TIME fully ccw.
Set ATTENUATORS fully cw, terminate pulse output into 50 ohm.
Sync scope from positive sync pulse output. View pulse output at SWEEP SPEED of 0.1 microsec/cm and with vertical sensitivity of 20v/cm.
See Repetition Rate Settings (Table 4-1).

**TABLE 4-1**

**REPETITION RATE CALIBRATION CHECK**

| REPETITION RATE | | WIDTH | SCOPE SWEEP SPEED | CORRECT SPACINGS | TOLERANCE |
|---|---|---|---|---|---|
| SWITCH | VERNIER | | | | |
| 2 mc | cw | Min. | 0.1 μs/cm | 0.33 μs (3 mc) | +0, -10% |
| 2 mc | ccw | Min. | 0.1 μs/cm | 0.5 μs (2 mc) | ±10% |
| 1 mc | ccw | Min. | 0.2 μs/cm | 1 μs (1 mc) | ±10% |
| 0.5 mc | ccw | Min. | 0.5 μs/cm | 2 μs (0.5 mc) | ±10% |
| 0.2 mc | ccw | Min. | 1 μs/cm | 5 μs (0.2 mc) | ±10% |
| 0.1 mc | ccw | Min. | 2 μs/cm | 10 μs (0.1 mc) | ±10% |
| 50 kc | ccw | Min. | 5 μs/cm | 20 μs (50 kc) | ±10% |
| 20 kc | ccw | 1 μs | 10 μs/cm | 50 μs (20 kc) | ±10% |
| 10 kc | ccw | 1 μs | 20 μs/cm | 100 μs (10 kc) | ±10% |
| 5 kc | ccw | 1 μs | 50 μs/cm | 200 μs (5 kc) | ±10% |
| 2 kc | ccw | 1 μs | 0.1 ms/cm | 0.5 ms (2 kc) | ±10% |
| 1 kc | ccw | 10 μs | 0.2 ms/cm | 1 ms (1 kc) | ±10% |

**TABLE 4-1**

**REPETITION RATE CALIBRATION CHECK** (Cont.)

| REPETITION RATE | | WIDTH | SCOPE SWEEP SPEED | CORRECT SPACINGS | TOLERANCE |
|---|---|---|---|---|---|
| SWITCH | VERNIER | | | | |
| 0.5 kc | ccw | 10 μs | 0.5 ms/cm | 2 ms (0.5 kc) | ±10% |
| 0.2 kc | ccw | 10 μs | 1 ms/cm | 5 ms (0.2 kc) | ±10% |
| 0.1 kc | ccw | 0.1 ms | 2 ms/cm | 10 ms (0.1 kc) | ±10% |
| 50 cps | ccw | 0.1 ms | 5 ms/cm | 20 ms (50 cps) | ±10% |
| 20 cps | ccw | 0.1 ms | 10 ms/cm | 50 ms (20 cps) | ±10% |
| 10 cps | ccw | 1 ms | 20 ms/cm | 100 ms (10 cps) | ±10% |
| 10 cps | cw | 1 ms | 5 ms/cm | Less than 47 ms | --- |
| 5 cps | cw | 1 ms | 10 ms/cm | Less than 95 ms | --- |
| 5 cps | ccw | 1 ms | 50 ms/cm | 200 ms (5 cps) | ±10% |
| 2 cps | ccw | 1 ms | 0.1 sec/cm | 0.5 sec (2 cps) | ±10% |
| 2 cps | cw | 1 ms | 20 ms/cm | Less than 190 ms | --- |

4.4.2 (cont.)

Set PULSE WIDTH to 0.5 microsec.
Set PULSE DELAY to 0.5 microsec.
Set REPETITION RATE and VERNIER fully cw.
Set SWEEP SPEED to 10 microsec/cm.
Expand sweep x 100.
View leading edge of 10th pulse and verify that jitter is less than 0.8 cm (0.8%).
Set REPETITION RATE switch to EXT, VERNIER fully ccw.
Set PULSE WIDTH to 0.5 microsec, VERNIER fully ccw.
Apply 20v rms sine wave at 500 kc to positive external trigger input jack.
Set SWEEP SPEED at 1 microsec/cm.
Verify triggering stability.
Remove sine wave input and apply 20v positive pulse (.1 microsec rise) 3 mc sweep speed .1 microsec/cm.
Verify triggering stability.
Remove pulse input.
Set PULSE WIDTH to 10 ms, VERNIER fully cw.
SWEEP SPEED 2 mc/cm.
Depress single pulse push button.
Verify occurrence of single pulse.
Set PULSE WIDTH to 0.5 microsec, VERNIER ccw.
Set PULSE DELAY to 0.5 microsec, VERNIER ccw.
Set PULSE REPETITION RATE to 2 mc, VERNIER cw.
Set SWEEP SPEED to 0.1 microsec/cm.
View sync pulse; verify amplitude is greater than 20v.
Terminate sync into 100 ohm.
Verify that amplitude is greater than 10v.

4.4.3 Pulse Delay

Set PULSE WIDTH control to 1 microsec, VERNIER fully cw (Min.)
Set POLARITY to "+", RISE TIME fully cw.
Set ATTENUATOR controls fully cw.
Terminate output pulse into 50 ohm.
Sync scope from positive sync output.
View output pulse and sync pulse simultaneously (dual trace).
SWEEP SPEED 0.1 microsec/cm, VERTICAL SENSITIVITY 20v/cm.
Note that delay is measured from the 50% point on leading edge of the sync pulse to the 50% point on the leading edge of the output pulse.
See Pulse Delay Settings. (Table 4-2)

**TABLE 4-2**
**PULSE DELAY CALIBRATION CHECK**

| REPETITION RATE | WIDTH | DELAY | | SCOPE SWEEP SPEED | CORRECT DELAY ±5% |
|---|---|---|---|---|---|
| | | SWITCH | VERNIER | | |
| 1 kc | 1 μs | 0.5 μs | ccw | 0.1 μs/cm | Approx. 0.2 μs |
| 1 kc | 1 μs | 0.5 μs | cw | 0.1 μs/cm | 0.5 μs |
| 1 kc | 1 μs | 1 μs | cw | 0.2 μs/cm | 1 μs |
| 1 kc | 1 μs | 2 μs | cw | 0.5 μs/cm | 2 μs |
| 1 kc | 1 μs | 5 μs | cw | 1 μs/cm | 5 μs |
| 1 kc | 1 μs | 10 μs | cw | 2 μs/cm | 10 μs |
| 1 kc | 1 μs | 20 μs | cw | 5 μs/cm | 20 μs |
| 1 kc | 1 μs | 50 μs | cw | 10 μs/cm | 50 μs |
| 1 kc | 1 μs | 0.1 ms | cw | 20 μs/cm | 0.1 ms |
| 0.1 kc | 1 μs | 0.2 ms | cw | 50 μs/cm | 0.2 ms |
| 0.1 kc | 1 μs | 0.5 ms | cw | 0.1 ms/cm | 0.5 ms |
| 0.1 kc | 1 μs | 1 ms | cw | 0.2 ms/cm | 1 ms |
| 10 cps | 0.1 ms | 2 ms | cw | 0.5 ms/cm | 2 ms |
| 10 cps | 0.1 ms | 2 ms | ccw | 0.1 ms/cm | Less than 0.95 ms |
| 10 cps | 0.1 ms | 5 ms | ccw | 0.2 ms/cm | Less than 1.9 ms |
| 10 cps | 0.1 ms | 5 ms | cw | 1 ms/cm | 5 ms |
| 10 cps | 0.1 ms | 10 ms | cw | 2 ms/cm | 10 ms |
| 10 cps | 0.1 ms | 10 ms | ccw | 0.5 ms/cm | Less than 4.7 ms |

Set PULSE REPETITION RATE to 0.1 kc, SWEEP SPEED 2 ms/cm.
Slowly turn PULSE DELAY VERNIER cw and verify that 70% duty cycle can be exceeded without circuit failure.
Set PULSE DELAY to 1 ms, VERNIER fully cw.
Set SWEEP SPEED at 0.2 ms/cm.
Expand sweep x 100 and view leading edge of pulse.
Verify that jitter is less than 1/2 cm (0.05%).

4.4.4 Pulse Width

Set PULSE DELAY control to 0.5 microsec, VERNIER fully ccw.
Set POLARITY control to "+", RISE TIME fully ccw.
Set ATTENUATOR controls fully cw.
Terminate output pulse into 50 ohm.
Sync scope from positive sync output.
View output pulse.
SWEEP SPEED 0.1 microsec/cm, VERTICAL SENSITIVITY 20v/cm.
Note that width is measured from the 50% point on the leading edge of the output pulse to the 50% point on the lagging edge of the output pulse.
See Pulse Width Settings. (Table 4-3)

TABLE 4-3
PULSE WIDTH CALIBRATION CHECK

| REPETITION RATE | PULSE WIDTH | | SCOPE SWEEP SPEED | CORRECT PULSE WIDTH ±10% |
|---|---|---|---|---|
| | SWITCH | VERNIER | | |
| 1 kc | 0.5 μs | ccw | 0.1 μs/cm | Approx. 0.5 μs |
| 1 kc | 0.5 μs | cw | 0.1 μs/cm | 0.5 μs |
| 1 kc | 1 μs | cw | 0.2 μs/cm | 1 μs |
| 1 kc | 2 μs | cw | 0.5 μs/cm | 2 μs |
| 1 kc | 5 μs | cw | 1 μs/cm | 5 μs |
| 1 kc | 10 μs | cw | 2 μs/cm | 10 μs |
| 1 kc | 20 μs | cw | 5 μs/cm | 20 μs |
| 1 kc | 50 μs | cw | 10 μs/cm | 50 μs |
| 1 kc | 0.1 ms | cw | 20 μs/cm | 0.1 ms |
| 0.1 kc | 0.2 ms | cw | 50 μs/cm | 0.2 ms |
| 0.1 kc | 0.5 ms | cw | 0.1 ms/cm | 0.5 ms |
| 0.1 kc | 1 ms | cw | 0.2 ms/cm | 1 ms |
| 10 cps | 2 ms | cw | 0.5 ms/cm | 2 ms |
| 10 cps | 2 ms | ccw | 0.1 ms/cm | Less than 0.95 ms |
| 10 cps | 5 ms | ccw | 0.2 ms/cm | Less than 1.9 ms |
| 10 cps | 5 ms | cw | 1 ms/cm | 5 ms |
| 10 cps | 10 ms | cw | 2 ms/cm | 10 ms |
| 10 cps | 10 ms | ccw | 0.5 ms/cm | Less than 4.7 ms |

Set PULSE WIDTH switch to 1 ms, VERNIER fully cw.
Set SWEEP SPEED at 0.2 ms/cm.
Expand sweep x 100 and view lagging edge of pulse.
Verify that jitter is less than 1/2 cm (0.05%).

4.4.5 Output Waveform

a. Set PULSE REPETITION RATE switch to 2 mc, VERNIER fully cw.
Set PULSE DELAY to 0.5 microsec, VERNIER fully ccw.
Set PULSE WIDTH to 0.5 microsec, VERNIER fully ccw.
Set POLARITY to "+", RISE TIME fully ccw.
Set ATTENUATOR controls fully cw.
Sync scope from positive sync output.
View output pulse terminated into 50 ohm.
SWEEP SPEED 0.1 microsec/cm; VERTICAL SENSITIVITY 20v/cm.

b. Observe that amplitude is equal to or greater than 50v.

c. Set POLARITY to "-".
Observe that amplitude is equal to or greater than 50v.

d. Set POLARITY to "+".

e. Step ATTENUATOR to 10 db in 2 db steps and observe with full amp. 60v.

2 db amplitude is 48v ±10%.
4 db amplitude is 38v ±10%.
6 db amplitude is 30v ±10%.
8 db amplitude is 24v ±10%.
10 db amplitude is 19v ±10%.

f. Return control fully cw.

g. Step ATTENUATOR to 50 db in 10 db steps. Observe.

10 db amplitude is 19v ±10%.
20 db amplitude is 6v ±10%.
30 db amplitude is 1.9v ±10%.
40 db amplitude is 0.6v ±10%.
50 db amplitude is 0.19v ±10%.

h. Return control fully cw.

i. Set REPETITION RATE control to 10 kc, VERNIER fully ccw.
Set PULSE WIDTH to 1 microsec, VERNIER fully cw.

j. Observe overshoot is less than 4% (it may be necessary to trim overshoot somewhat with rise time control).

k. Set RISE TIME control fully cw.
Observe that RISE TIME is greater than 0.5 microsec.

l. Set REPETITION RATE to 50 cps.
Set PULSE WIDTH to 1 ms, SWEEP SPEED 0.2 ms/cm.

m. Observe TOP SLOPE is less than 3%.

n. Set REPETITION RATE to 10 kc.
Set PULSE WIDTH to 0.5 microsec, VERNIER fully ccw.
Observe output waveform terminated into 50 ohm on sampling oscilloscope.

o. Observe that rise and decay times are equal to or less than 10 nanosec (from 10% to 90% point on leading edge and lagging edge respectively).

p. De-energize equipment. Using a device such as VECTOR T80C, insert an ammeter in plate circuit of V27 taking care that both halves of tube are connected through the ammeter. Connect a voltmeter from TP10 (+225v) to ground.

q. Energize equipment.

r. Set PULSE REPETITION RATE to 0.1 mc, VERNIER centered.
Set PULSE DELAY to 0.5 microsec, VERNIER fully ccw.
Set PULSE WIDTH to 2 microsec, VERNIER fully ccw.

s. Slowly turn PULSE WIDTH VERNIER cw noting ammeter reading.
Verify that average pulse current overload lamp lights at approximately 220 ma.

t. Continue increasing duty cycle and note that +225v supply decreases in voltage at 225 ma.

u. De-energize equipment and remove ammeter and voltmeter.

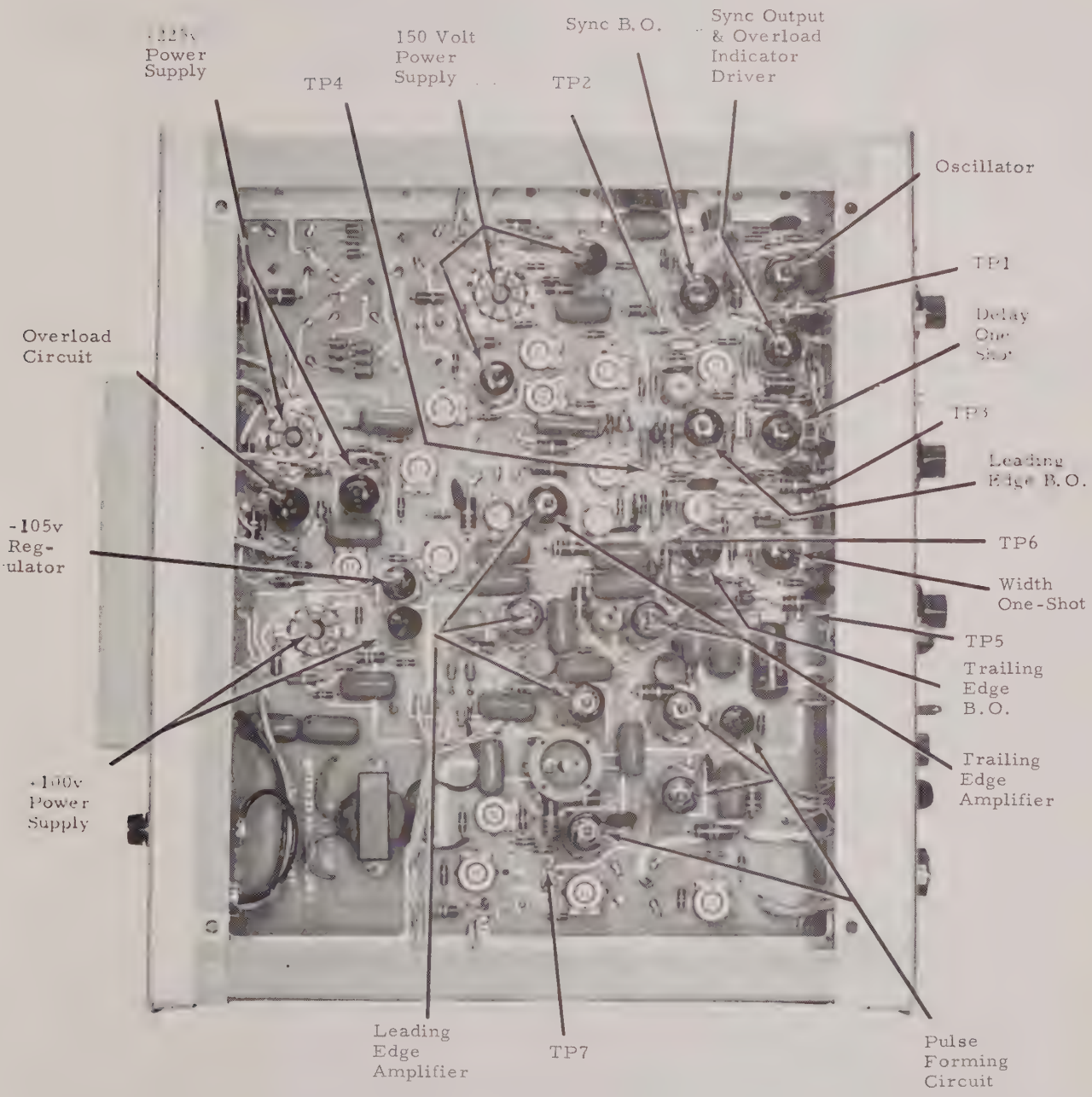
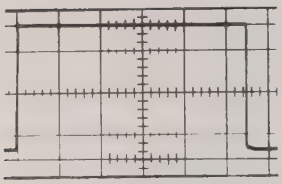



FIGURE 4-2. MODEL 102 TEST POINTS AND CIRCUIT LOCATIONS

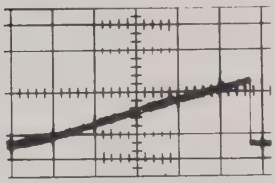
FIGURE 4-1. WAVEFORM SUMMARY

## TROUBLE SHOOTING AIDS

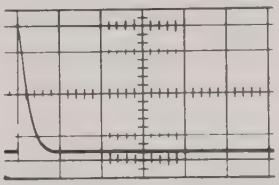
Sweep Speed 0.2 μs/cm---Vertical Sensitivity 20v/cm



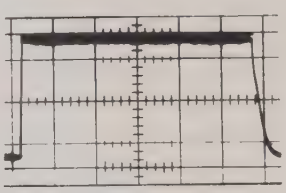
Proper Waveform



Loss of Leading Trigger; Check V8A, V10, V11, or V13



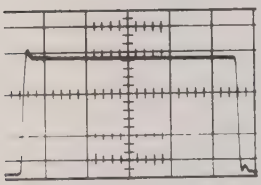
Loss of Duration Gate; Check V6 or V14



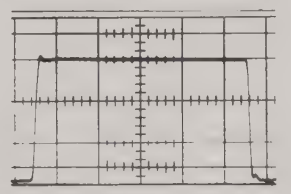
Loss of Trailing Edge Trigger; Check V7, V8B, V9 or V12

## CONTROLS FOR WAVEFORM TRIMMING

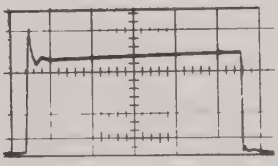
Sweep Speed 0.2 μs/cm---Vertical Sensitivity 20v/cm



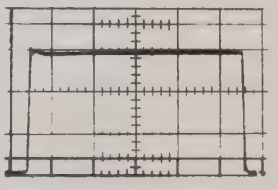
Rise Time not Compensated



Rise Time Control Turned Slightly Cw (Proper Waveform)

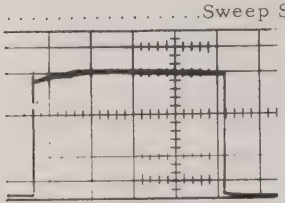


Overshoot C34 Overcompensated

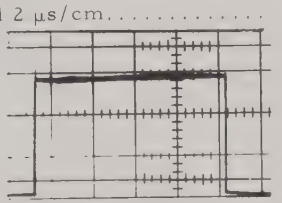


Overshoot C34 Undercompensated

Sweep Speed 2 μs/cm

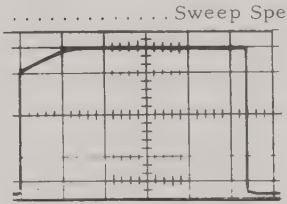


Roll C39 Overcompensated

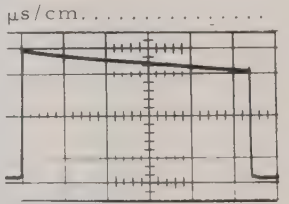


Roll C39 Undercompensated

Sweep Speed 20 μs/cm



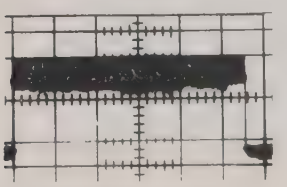
Top Slope R260 Overcompensated



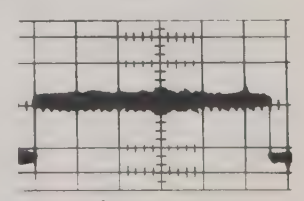
Top Slope R260 Undercompensated

## EFFECT OF AVERAGE PULSE CURRENT OVERLOAD CIRCUIT

Sweep Speed 10 μs/cm---Vertical Sensitivity 20v/cm



Slight Overload



Extreme Overload

## TABLE 4-4

## VOLTAGE AND RESISTANCE

Measurements were taken under the following conditions:

All measurements are with respect to ground.

Resistance measurements with negative meter terminal connected to ground.

All voltages are dc unless noted.

Voltage measurements are at 115v ac line.

Measurements were made with Simpson Model 260 (20,000 ohms per volt).

Repetition rate control was on EXT.

Pulse Delay control was on 0.5 microsec.

Pulse Width control was on 0.5 microsec.

Both attenuation controls were on "0".

Polarity switch was on "+".

The voltages and resistances tabulated here are typical values. On some instruments the readings will differ considerably from this tabulation due to manufacturing tolerances and variations in component characteristics. These tables should be used in conjunction with careful study of the schematic diagrams and the "Theory of Operation" section of this manual.

| | VOLTAGE PIN NUMBER | | | | | | | | | RESISTANCE PIN NUMBER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TUBE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| V1: 6DJ8 | +70 | 0 | +25 | 0 | 6.3 ac | +75 | +25 | +25 | --- | 150k | 10k | 780 Ω | 0 | 0 | 100k | 1k | 780 Ω | --- |
| V2: 6DJ8 | +100 | -5.6 | 0 | 0 | 6.3 ac | +100 | -5.6 | 0 | --- | 100k | 5k | 0 | 0 | 0 | 100k | 400 Ω | 470 Ω | --- |
| V3: 6DJ8 | +10 | 0 | 0 | 6.3 ac | 0 | +100 | 0 | +3 | --- | 130k | 200k | 0 | 0 | 0 | 100k | 470 Ω | 470 Ω | --- |
| V4: 6DJ8 | +2 | 0 | 0 | 6.3 ac | 0 | +100 | -4 | 0 | --- | 200k | ∞ | 50Ω | 0 | 0 | 100k | 150 k | 50Ω | --- |
| V5: 6DJ8 | +100 | -5.6 | 0 | 0 | 6.3 ac | +100 | -5.6 | 0 | --- | 100k | 3k | 0 | 0 | 0 | 100k | 500 Ω | 3Ω | --- |
| V6: 6DJ8 | +2 | 0 | 0 | 6.3 ac | 0 | +100 | -4 | 0 | --- | 200k | ∞ | 50Ω | 0 | 0 | 100k | 150 k | 50Ω | --- |
| V7: 6DJ8 | +100 | -5.6 | 0 | 6.3 ac | 0 | +100 | -5.6 | 0 | --- | 100k | 3k | 0 | 0 | 0 | 100k | 1k | 3Ω | --- |
| V8: 6DJ8 | +100 | -5.6 | 0 | 0 | 6.3 ac | +100 | -5.6 | 0 | 0 | 100k | 1.5k | 0 | 0 | 0 | 100k | 1k | 0 | 0 |
| V9: 7119 | +225 | -18 | 0 | 6.3 ac | 6.3 ac | 0 | -18 | 0 | +225 | 300k | 100Ω | 0 | 0 | 0 | 0 | 10Ω | 0 | 300k |
| V10: 7119 | +225 | -18 | 0 | 6.3 ac | 6.3 ac | 0 | -18 | 0 | +225 | 300k | 10Ω | 0 | 0 | 0 | 0 | 10Ω | 0 | 300k |
| V11: 7119 | +225 | -18 | 0 | 6.3 ac | 6.3 ac | 0 | -18 | 0 | +225 | 300k | 10Ω | 0 | 0 | 0 | 0 | 10Ω | 0 | 300k |
| V12: 7119 | +2 | -18 | 0 | 6.3 ac | 6.3 ac | 0 | -18 | 0 | +12 | 300k | 10Ω | 0 | 0 | 0 | 0 | 10Ω | 0 | 10k |
| V13: 7119 | 0 | 0 | +2 | 6.3 ac | 6.3 ac | +2 | 0 | 0 | 0 | 0 | 0 | 300k | 0 | 0 | 300k | 0 | 0 | 0 |
| V14: 6AU6 | 0 | 0 | 6.3 ac | 0 | +2 | +100 | 0 | | | ∞ | 0 | 0 | 0 | 300k | 100k | 0 | | |
| V15: 7119 | +225 | +2 | +12 | 6.3 ac | 6.3 ac | +12 | +2 | 0 | +225 | 300k | 300k | 10k | 0 | 0 | 10k | 300 k | 0 | 300k |
| V16:12BH7 | 0 | -40 | -40 | 3.15 ac | 3.15 ac | +150 | +150 | +150 | 3.15 ac | 0 | 300k | 150k | 0 | 0 | 500k | 500 k | ∞ | 0 |
| V17: 6DQ5 | -40 | 3.15 ac | 0 | +150 | -40 | 0 | 3.15 ac | +150 | +150* | 150k | 0 | 50Ω | ∞ | 150k | 50Ω | 0 | ∞ | 500k * |
| V18: 6DQ5 | -40 | 3.15 ac | 0 | +150 | -40 | 0 | 3.15 ac | +150 | +150* | 150k | 0 | 50Ω | ∞ | 150k | 50Ω | 0 | ∞ | 500k * |
| V19: QB2 | 0 | -105 | 0 | -105 | 0 | 0 | -105 | | | 0 | 3.5k | ∞ | 3.5 k | 0 | ∞ | 3.5 k | | |
| V20:6AU6 | -30 | 0 | 6.3 ac | 0 | +75 | +85 | | | | 200k | 0 | 0 | 0 | 1.5m | 100k | 0 | | |
| V21:6AS7 | +75 | +200 | +100 | +75 | +200 | +100 | 0 | 6.3 ac | | 1.5m | 100k | 100k | 1.5 m | 100k | 100k | 0 | 0 | |
| V22:6U8A | +45 | -10 | +100 | 6.3 ac | 0 | +150 | 0 | 0 | 0 | 100k | 400k | 100k | 0 | 0 | 1.5m | 0 | 0 | 400k |
| V23:6AS7 | +130 | +320 | +225 | +130 | +320 | +225 | 6.3 ac | 0 | --- | 1.5m | 200k | 300k | 1.5 m | 200k | 300k | 0 | 0 | --- |

*: Plate Cap

Continued------

**TABLE 4-4** (Continued)
**VOLTAGE AND RESISTANCE**

| | VOLTAGE PIN NUMBER | | | | | | | | | RESISTANCE PIN NUMBER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TUBE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| V24:6U8A | +100 | -10 | +130 | 6.3 ac | 0 | +130 | 0 | 0 | -4 | 100k | 200k | 100k | 0 | 0 | 1.5m | 0 | 0 | 250k |
| V25: OB2 | 0 | -105 | 0 | -105 | 0 | 0 | -105 | | | 0 | 20k | ∞ | 20k | 0 | ∞ | 20k | | |
| V26:6AU6 | -4 | 0 | 6.3 ac | 0 | +65 | +125 | 0 | | | 100k | 0 | 0 | 0 | 1.5 m | 80k | 0 | | |
| V27:6AS7 | +65 | +250 | +150 | +65 | +250 | +150 | 0 | 6.3 ac | | 1.5 m | 100k | 500k | 1.5 m | 100k | 500k | 0 | 0 | |

# SECTION V

# PARTS LIST

## 5.1 HOW TO USE THIS PARTS LIST.

### 5.1.1 Reference Designations

Reference designations used throughout this listing correspond with reference designations given on component location photos and the following schematics:

Drawing No. 37000-005
Drawing No. 40000-001
Drawing No. 37000-006
Drawing No. 40000-002
Drawing No. 37000-007
Drawing No. 40000-003
Drawing No. 37000-000
Drawing No. 37000-001
Drawing No. 40000-004
Drawing No. 40000-000

Resistors are designated as R1, R2, R3, etc. and are fixed value, composition, 10% and 1/2 w unless otherwise noted.

Capacitors are designated as C1, C2, C3, etc. and are fixed value, 10%, 500v dc unless otherwise noted.

Diodes are designated as CR1, CR2, CR3; switches as S1, S2, S3; and inductors as L1, L2, and L3, etc.

### 5.1.2 Abbreviations

The following abbreviations are used:

| | |
|---|---|
| CER | - Ceramic |
| DPC | - Deposited Carbon |
| ELECT | - Electrolytic |
| M | - Mica |
| MP | - Metalized Paper |
| GMV | - Guaranteed Min. Value |
| OF | - Oil Filled |
| PT | - Paper Tubular |
| SM | - Silver Mica |
| VAR | - Var. |
| WW | - Wire Wound |
| VTQ | - Vitamin Q |
| PNP | - Positive-Negative-Positive |
| NPN | - Negative-Positive-Negative |
| µsec | - Microsecond |
| µF | - Microfarad |
| µh | - Microhenry |
| ns | - Nanosecond |
| ms | - Millisecond |

## 5.2 RESISTORS

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR.) & MFR'S PART NO. |
|---|---|---|---|---|
| R1 | 20 | 47 Ω | 10021-470 | (AB)* EB4701 |
| R2 | 4 | 10 k | 10021-103 | (AB) EB1031 |
| R3 | | Same as R2 | | |
| R4 | | Same as R1 | | |
| R5 | 2 | 100 Ω, 5% | 10011-101 | (AB) EB1015 |
| R6 | 1 | 15 k, 1 w | 10022-153 | (AB) GB1531 |
| R7 | 1 | 22 k | 10021-223 | (AB) EB2231 |
| R8 | 7 | 1 k, 2 w | 10023-102 | (AB) HB1021 |
| R9 | 4 | 1 k | 10021-102 | (AB) EB1021 |
| R10 | 1 | 180 k | 10021-184 | (AB) EB1841 |
| R11 | 2 | 3.3 k | 10021-332 | (AB) EB3321 |
| R12 | | Same as R1 | | |
| R13 | 4 | 470 Ω, 1 w | 10022-471 | (AB) GB4711 |
| R14 | 2 | 220 Ω | 10021-221 | (AB) EB2211 |
| R15 | | Same as R9 | | |
| R16 | | Same as R13 | | |
| R17 | | Same as R1 | | |
| R18 | | Same as R1 | | |
| R19 | 13 | 100 k | 10021-104 | (AB) EB1031 |
| R20 | 2 | 27 k | 10021-273 | (AB) EB2731 |
| R21 | 6 | 47 Ω, 5% | 10011-470 | (AB) EB4705 |
| R22 | | Same as R19 | | |
| R23 | | Same as R20 | | |
| R24 | | Same as R21 | | |
| R25 | | Same as R2 | | |
| R26 | | Same as R2 | | |
| R27 | 9 | 470 Ω, 2 w | 10023-471 | (AB) HB4711 |
| R28 | 2 | 270 k | 10021-274 | (AB) EB2741 |
| R29 | | Same as R27 | | |
| R30 | | Same as R28 | | |
| R31 | 2 | 2.2 k | 10021-222 | (AB) EB2221 |

*(AB)-Allen Bradley

5.2 RESISTORS (Cont.)

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR.) & MFR'S PART NO. |
|---|---|---|---|---|
| R32 | | Same as R9 | | |
| R33 | | Same as R31 | | |
| R34 | | Same as R1 | | |
| R35 | | Same as R13 | | |
| R36 | | Same as R1 | | |
| R37 | | Same as R13 | | |
| R38 | | Same as R14 | | |
| R39 | | Same as R9 | | |
| R40 | | Same as R27 | | |
| R41 | | Same as R11 | | |
| R42 | | Same as R1 | | |
| R43 | | Same as R1 | | |
| R44 | | Same as R27 | | |
| R45 | | Same as R27 | | |
| R46 | | Same as R1 | | |
| R47 | | Same as R1 | | |
| R48 | | Same as R27 | | |
| R49 | | Same as R27 | | |
| R50 | | Same as R1 | | |
| R51 | | Same as R1 | | |
| R52 | | Same as R27 | | |
| R53 | | Same as R27 | | |
| R54 | 2 | 22 Ω | 10021-220 | (AB) EB2201 |
| R55 | 11 | 680 Ω, 2 w | 10023-681 | (AB) HB6811 |
| R56 | | Same as R55 | | |
| R57 | 3 | 3.3 m | 10021-335 | (AB) EB3351 |
| R58 | | Same as R54 | | |
| R59 | 3 | 220 k | 10021-224 | (AB) EB2241 |
| R60 | 9 | Var., 250 k, 2 w, 30% | 20240-254 | (CTS)* 33351 |
| R61 | 1 | Same as R19 | | |
| R62 | | 150 k | 10021-154 | (AB) EB1541 |
| R63 | 9 | 10 k, 2 w | 10023-103 | (AB) HB1031 |
| R64 | 1 | Var., 5 k, 2 w | 20053-502 | (AB) Jain0565502UA |
| R65 | | Same as R54 | | |
| R66 | 1 | 4.7 k | 10021-472 | (AB) EB4721 |
| R67 | | Same as R19 | | |
| R68 | 1 | 330 Ω, 2 w | 10023-331 | (AB) HB3311 |
| R69 | 6 | 10 Ω | 10021-100 | (AB) EB1001 |
| R70 | 8 | 2.7 Ω, 1 w | 10022-279 | (AB) GB27G1 |
| R71 | 8 | 10 Ω, 2 w | 10023-100 | (AB) EB6805 |
| R72 | | Same as R69 | | |
| R73 | | Same as R70 | | |
| R74 | | Same as R69 | | |
| R75 | | Same as R70 | | |
| R76 | | Same as R71 | | |
| R77 | | Same as R69 | | |
| R78 | | Same as R70 | | |
| R79 | | Not Used | | |
| R80 | 7 | 150 Ω, 2 w | 10023-151 | (AB) HB1511 |
| R81 | | Same as R80 | | |
| R82 | | Same as R80 | | |
| R83 | | Same as R80 | | |
| R84 | | Same as R80 | | |
| R85 | | Same as R80 | | |
| R86 | | Same as R69 | | |
| R87 | | Same as R19 | | |
| R88 | | Same as R60 | | |
| R89 | | 68k | 10021-683 | (AB) EB6831 |
| R90 | | Same as R60 | | |
| R91 | | Same as R19 | | |
| R92 | 3 | 100 k, 1 w | 10022-104 | (AB) GB1041 |
| R93 | | Same as R19 | | |
| R94 | 3 | 1 m | 10021-105 | (AB) EB1051 |

5.2 RESISTORS (Cont.)

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR,) & MFR'S PART NO. |
|---|---|---|---|---|
| R95 | | Same as R1 | | |
| R96 | | Same as R1 | | |
| R97 | 8 | 22 Ω, 1 w | 10022-220 | (AB) GB2201 |
| R98 | | Same as R97 | | |
| R99 | | Same as R19 | | |
| R100 | | Same as R60 | | |
| R101 | | Same as R89 | 10021-683 | (AB) EB6831 |
| R102 | 8 | 2.7 Ω | 10022-279 | (AB) GB27G1 |
| R103 | | Same as R97 | | |
| R104 | 3 | 3.3 k, 2 w | 10023-332 | (AB) HB3321 |
| R105 | | Same as R104 | | |
| R106 | | Same as R104 | | |
| R107 | | Same as R97 | | |
| R108 | | Same as R8 | | |
| R109 | | Same as R8 | | |
| R110 | | Same as R80 | | |
| R111 | 2 | 470 Ω | 10021-471 | (AB) EB4711 |
| R112 | | Same as R92 | | |
| R113 | | Same as R19 | | |
| R114 | | Same as R92 | | |
| R115 | | Same as R19 | | |
| R116 | | Same as R94 | | |
| R117 | | Same as R94 | | |
| R118 | | Same as R1 | | |
| R119 | | Same as R1 | | |
| R120 | | Same as R1 | | |
| R121 | | Same as R1 | | |
| R122 | | Same as R97 | | |
| R123 | | Same as R97 | | |
| R124 | | Same as R97 | | |
| R125 | | Same as R97 | | |
| R126 | 3 | 470 k | 10021-474 | (AB) EB4741 |
| R127 | | Same as R60 | | |
| R128 | | Same as R19 | | |
| R129 | | Same as R19 | | |
| R130 | | Same as R60 | | |
| R131 | | Same as R19 | | |
| R132 | | Same as R59 | | |
| R133 | 1 | 1.5 m | 10021-155 | (AB) EB1551 |
| R134 | | Same as R19 | | |
| R135 | | Same as R60 | | |
| R136 | | Same as R60 | | |
| R137 | | Same as R59 | | |
| R138 | 1 | 33 k | 10021-333 | (AB) EB3331 |
| R139 | 2 | 10 k, 1 w | 10022-103 | (AB) GB1031 |
| R140 | | Same as 126 | | |
| R141 | 2 | 680 k | 10021-684 | (AB) EB6841 |
| R142 | | Same as R139 | | |
| R143 | | Same as R126 | | |
| R144 | | Same as R141 | | |
| R145 | | Same as R1 | | |
| R146 | | Not Used | | |
| R147 | 1 | 100 Ω | 10021-101 | (AB) EB1011 |
| R148 | | Through 200 - not used | | |

5.2 RESISTORS (Cont.)

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR.) & MFR'S. PART NO. |
|---|---|---|---|---|
| R201 | 4 | Var., W.W., 500 Ω, 2 w, 20% | 10603-501 | (CTS) Series 112 |
| R202 | | Same as R201 | | |
| R203 | | Same as R201 | | |
| R204 | 1 | 3.3 k, 5% | 10011-332 | (AB) EB3325 |
| R205 | 1 | 150 k, 5% | 10011-154 | (AB) EB1545 |
| R206 | 1 | 270k, 5% | 10011-274 | (AB) EB2745 |
| R207A, B | 3 | Var., 500 Ω x 2 m dual 20%, 2 w | 20213-205 | |
| R208 | 1 | 200 k, 5% | 10011-204 | (AB) EB2045 |
| R209 | 2 | 510 k, 5% | 10011-514 | (AB) EB5145 |
| R210 | 1 | 680 k, 5% | 10011-684 | (AB) EB6845 |
| R211 | | Same as R60 | | |
| R212 | 1 | 470 k, 5% | 10011-474 | (AB) EB4745 |
| R213 | | Same as R209 | | |
| R214 | | Same as R201 | | |
| R215 | | Same as R111 | | |
| R216 | 1 | 330 Ω, 2 w, 5% | 10013-331 | (AB) HB3305 |
| R217 | 8 | 36 Ω, 5% | 10011-360 | (AB) EB3605 |
| R218 | | Same as R5 | | |
| R219 | 1 | 270 Ω, 5% | 10011-271 | (AB) EB2715 |
| R220 | 1 | 47 K, 5% | 10011-473 | (AB) EB4735 |
| R221 | 3 | Var., 500 k, 2 w, 30% | 20240-104 | (CTS) 33803 |
| R222 | 1 | 1 m, 0.2 w, 30% | 20240-105 | (CTS) 33803 |
| R223 | | Not Used | | |
| R301 | | Same as R221 | | |
| R302 | | Same as R57 | | |
| R303A, B | | Same as R207A, B | | |
| R304 | 2 | 330 k, 5% | 10011-334 | (AB) EB3345 |
| R305 | 2 | 62 Ω, 5% | 10011-680 | (AB) EB6805 |
| R306 | 4 | 150 Ω, 5% | 10011-151 | (AB) EB1515 |
| R307 | | Same as R306 | | |
| R308 | 1 | 68Ω. 5% | 10011-680 | (AB) EB6805 |
| R309 | | Same as R69 | | |
| R310 | | Not Used | | |
| R401 | | Same as R221 | | |
| R402 | | Same as R57 | | |
| R403A, B | | Same as R207A, B | | |
| R404 | | Same as R304 | | |
| R405 | | Same as R305 | | |
| R406 | | Same as R306 | | |
| R407 | | Same as R306 | | |
| R408 | | Same as R21 | | |
| R409 | | Same as R69 | | |

5.2 RESISTORS (Cont.)

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR.) & MFR'S. PART NO. |
|---|---|---|---|---|
| R501 | 1 | Var., 50 Ω, 2 w | 20053-500 | (AB) Jain0565500UA |
| R502 | 1 | 47 Ω, 2 w | 10023-470 | (AB) HB4701 |
| R503 | | Same as R71 | | |
| R504 | | Same as R71 | | |
| R505 | | Same as R71 | | |
| R506 | | Same as R71 | | |
| R507 | | Same as R63 | | |
| R508 | | Same as R63 | | |
| R509 | | Same as R63 | | |
| R510 | | Same as R63 | | |
| R511 | | Same as R63 | | |
| R512 | | Same as R63 | | |
| R513 | | Same as R63 | | |
| R514 | | Same as R63 | | |
| R515 | | Same as R71 | | |
| R516 | 2 | 15 Ω, 1 w | 10022-150 | (AB) GB1501 |
| R517 | | Same as R516 | | |
| R518 | | Same as R71 | | |
| R519 | | Same as R8 | | |
| R520 | | Same as R8 | | |
| R521 | | Same as R8 | | |
| R522 | | Same as R8 | | |
| R523 | 1 | 1.5 k, 2 w | 10023-152 | (AB) HB1521 |
| R524 | 8 | 5.6 Ω, 1 w | 10022-569 | (AB) GB56G1 |
| R525 | | Same as R524 | | |
| R526 | 4 | 820 Ω, 2 w | 10023-821 | (AB) HB8211 |
| R527 | | Same as R526 | | |
| R528 | | Same as R526 | | |
| R529 | | Same as R526 | | |
| R530 | | Same as R524 | | |
| R531 | | Same as R524 | | |
| R532 | | Same as R55 | | |
| R533 | | Same as R55 | | |
| R534 | | Same as R55 | | |
| R535 | | Same as R524 | | |
| R536 | | Same as R524 | | |
| R537 | | Same as R55 | | |
| R538 | | Same as R55 | | |
| R539 | | Same as R55 | | |
| R540 | | Same as R524 | | |
| R541 | | Same as R524 | | |
| R542 | | Same as R55 | | |
| R543 | | Same as R55 | | |
| R544 | | Same as R55 | | |
| R545 | 11 | 36 Ω, 2 w, 5% | 10013-360 | (AB) HB3601 |
| R546 | | Same as R545 | | |
| R547 | | Same as R545 | | |
| R548 | | Same as R545 | | |
| R549 | | Same as R545 | | |
| R550 | | Same as R545 | | |
| R551 | | Same as R545 | | |
| R552 | | Same as R545 | | |
| R553 | | Same as R545 | | |
| R554 | | Same as R545 | | |
| R555 | 8 | 390 Ω, 2 w, 5% | 10013-391 | (AB) HB3915 |
| R556 | | Same as R555 | | |
| R557 | | Same as R555 | | |
| R558 | | Same as R555 | | |
| R559 | | Same as R555 | | |
| R560 | | Same as R555 | | |
| R561 | | Same as R555 | | |
| R562 | | Same as R555 | | |
| R563 | | Same as R545 | | |

5.2 RESISTORS (Cont.)

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR.) & MFR'S. PART NO. |
|---|---|---|---|---|
| R564 | | Same as R217 | | |
| R565 | 1 | 47 Ω, 2 w, 5% | 10013-470 | (AB) HB4705 |
| R566 | | Same as R217 | | |
| R567 | | Same as R217 | | |
| R568 | | Same as R21 | | |
| R569 | | Same as R217 | | |
| R570 | | Same as R217 | | |
| R571 | | Same as R21 | | |
| R572 | | Same as R217 | | |
| R573 | | Same as R217 | | |
| R574 | | Same as R21 | | |
| R575 | | Same as R70 | | |
| R576 | | Same as R70 | | |
| R577 | | Same as R70 | | |

5.3 CAPACITORS

| | | | | |
|---|---|---|---|---|
| C1 | 1 | .02 μF, $^{+80\%}_{-20}$, Cer. Disc | 11247-203 | (Er) 841-000 |
| C2 | 18 | .1 μF, 400v, Paper Mylar | 11066-103 | (Ar) 4DP-3-104 |
| C3 | 2 | 27 μμF, 5%, SM | 11017-270 | (Sa) RR1427 |
| C4 | 17 | .01μf $^{+80\%}_{-20}$. Cer. Disc. | 11247-103 | (ER) 841-000 |
| C5 | 2 | 100 μμF, | 11017-101 | ---- RR1310 |
| C6 | | Same as C4 | | |
| C7 | | Same as C2 | | |
| C8 | 3 | 470 μμF, 300v, 5%, SM | 11015-471 | (Sa) RR06347 |
| C9 | 4 | 47 μμF, 5%, SM | 11017-470 | (Sa) RR1447 |
| C10 | | Same as C9 | | |
| C11 | 2 | 15 μμF, 5%, SM | 11017-150 | (Sa) RR1415 |
| C12 | | Same as C11 | | |
| C13 | | Same as C4 | | |
| C14 | | Same as C2 | | |
| C15 | | Same as C2 | | |
| C16 | | Same as C9 | | |
| C17 | | Same as C9 | | |
| C18 | | Same as C8 | | |
| C19 | | Same as C4 | | |
| C20 | | Same as C4 | | |
| C21 | 1 | 1000 μμF, 5%, SM | 11037-102 | (Sa) KR1210 |
| C22 | | Same as C | | |
| C23 | | Same as C8 | | |
| C24 | | Same as C4 | | |
| C25 | | Same as C4 | | |
| C26 | 4 | .1 μf. 100v, 10% | 11083-104 | |
| C27 | | Same as C26 | | |
| C28 | | Same as C2 | | |
| C29 | | Same as C2 | | |
| C30 | | Same as C2 | | |
| C31 | | Same as C26 | | |
| C32 | | Same as C2 | | |
| C33 | | Same as C26 | | |
| C34 | 8 | 4-30 to 7μμf, Var. Cer. | 11307-300 | (Er) 503-000 |
| C35 | 1 | 5 μF, 200v, Paper Mylar | 11064-504 | (Ar) 2DP-5-504 |
| C36 | | Same as C2 | | |
| C37 | | Same as C2 | | |
| C38 | | Same as C2 | | |
| C39 | | Same as C34 | | |
| C40 | 2 | 20 μF, 250 | 11154-206 | (CD) BR-20-250 |
| C41 | | Same as | | |
| C42 | 7 | 150 μF, 350v, Elect, P.C. Mntg. | 11165-157 | (Sa) PLP-150-350v |
| C43 | | Same as C2 | | |
| C44 | | Same as C 4 | | |
| C45 | | Same as C42 | | |
| C46 | | Not Used | | |

=(Er)-Erie

5.3 CAPACITORS (Cont.)

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR.) & MFR'S PART NO. |
|---|---|---|---|---|
| C47 | 1 | 220 μμF, 5%, SM | 11017-221 | (Sa)* RR1322 |
| C48 | | Same as C2 | | |
| C49 | | Same as C42 | | |
| C50 | | Same as C42 | | |
| C51 | | Same as C42 | | |
| C52 | | Same as C42 | | |
| C53 | | Same as C42 | | |
| C54 | 1 | 1500 μF, 50v, ELECT, PC Mntg. | 11162-158 | (Sa) PLP1500-50 |
| C55 | | Same as C4 | | |
| C56 | | Same as C4 | | |
| C57 | | Same as C4 | | |
| C58 | | Same as C4 | | |
| C59 | | Same as C4 | | |
| C60 | | Same as C4 | | |
| C61 | | Same as C4 | | |
| C62 | | Same as C4 | | |
| C63 | | Same as C4 | | |
| C64 | | Same as C4 | | |
| C65 | | Same as C4 | | |
| C66 | | Same as C2 | | |
| C67 | | Same as C2 | | |
| C68 | | Same as C2 | | |
| C69 | | Same as C40 | | |
| C70 | | Same as C2 | | |
| C71 | | Same as C2 | | |
| C72 | | Same as C2 | | |
| C73 | | Not Used | | |
| C74 | | Not Used | | |
| C75 | | Not Used | | |
| C76 | | Not Used | | |
| C77 | | Same as C3 | | |
| C78 through 200 | | Not used | | |
| C201 | 3 | .1 μF, 200v, 1%, VTQ | 11093-104 | (Ec)* 250 |
| C202 | 1 | 1.0 μF, 1%, VTQ | 11093-105 | (Ec) 250 |
| C203 | | Same as C34 | | |
| C204 | 3 | .01 μF, 300v, 1%, SM | 11025-103 | (Sa) CR1110F |
| C205 | 3 | 1000 μμF, 1%, SM | 11027-102 | (Sa) CR1210 |
| C206 | | Same as C34 | | |
| C207 | 1 | 68 μμF, 5%, SM | 11017-680 | (Sa) RR1468 |
| C208 through 300 | | Not Used | | |

*=(Sa)-Sangamo - (Ec)-Electrocube - (Ar)-Arco

5.3 CAPACITORS (Cont.)

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR.) & MFR'S PART NO. |
|---|---|---|---|---|
| C301 | 2 | 82 μμF, 5%, SM | 11017-820 | (Sa) RR1482 |
| C302 | | Same as C34 | | |
| C303 | | Same as C205 | | |
| C304 | | Same as C204 | | |
| C305 | | Same as C201 | | |
| C306 | | Same as C34 | | |
| C307 through C400 | | Not Used | | |
| C401 | | Same as C301 | | |
| C402 | | Same as C34 | | |
| C403 | | Same as C205 | | |
| C404 | | Same as C204 | | |
| C405 | | Same as C201 | | |
| C406 | | Same as C34 | | |
| C407 through C500 | | Not Used | | |
| C501 | | Same as C5 | | |

5.4 TUBES (Vacuum Type Unless Otherwise Noted)

| | | | | |
|---|---|---|---|---|
| V1 | 8 | 6 DJ8, 8-Pin, 6.3v Fil., .365a | 12012-000 | (Am)* 6DJ8 |
| V2 | | Same as V1 | | |
| V3 | | Same as V1 | | |
| V4 | | Same as V1 | | |
| V5 | | Same as V1 | | |
| V6 | | Same as V1 | | |
| V7 | | Same as V1 | | |
| V8 | | Same as V1 | | |
| V9 | 6 | 7119, 9-Pin, 6.3/12.6v Fil | 12032-001 | (Am) 7119 |
| V10 | | Same as V9 | | |
| V11 | | Same as V9 | | |
| V12 | | Same as V9 | | |
| V13 | | Same as V9 | | |
| V14 | 3 | 6AU6A, 7-Pin, 6.3/12.6v Fil. | 12030-000 | (RCA) 6AU6A |
| V15 | | Same as V9 | | |
| V16 | 1 | 12BH7A, 9-Pin, 6.3/12.6v Fil. | 12032-000 | (RCA) 12BH7A |
| V17 | 2 | 6DQ5, 8-Pin, 6.3v Fil, 2.5a | 12011-000 | (RCA) 6DG5 |
| V18 | | Same as V17 | | |
| V19 | 2 | OB2, GAS, 7-Pin, Ref. Type | 12060-000 | (TS)* OB2 |
| V20 | | Same as V14 | | |
| V21 | 3 | 6AS7GA, 8-Pin, 6.3v Fil., 2.5a | 12011-001 | (RCA) 6AS7GA |
| V22 | 2 | 6U8A, 9-Pin, 6.3v Fil., .45a | 12012-001 | (RCA) 6AU8A |
| V23 | | Same as V21 | | |
| V24 | | Same as V22 | | |
| V25 | | Same as V19 | | |
| V26 | | Same as V14 | | |
| V27 | | Same as V21 | | |

*=(Am)-Ampex - (TS)-Tung-sol

5.5 MISCELLANEOUS

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR.) & MFR.'S PART NO. |
|---|---|---|---|---|
| DL1 | 1 | Delay Line, .09 μs, 500 Ω, wire leads | 14200-001 | (MC)* DDL500-.09 |
| CR1 | 4 | Diode, Silicon, DP16-0, 40v Computer | Z2164 | IN3600 |
| CR2 | | Same as CR | | |
| CR3 | 5 | Diode, Germanium IN34A 60v, Gen. Purpose | 12104-003 | (Sy)* IN34A |
| CR4 | | Same as CR3 | | |
| CR5 | | Same as CR3 | | |
| CR6 | | Same as CR3 | | |
| CR7 | | Same as CR1 | | |
| CR8 | | Same as CR1 | | |
| CR9 | 1 | Diode, Silicon, DP19-1** Power | 12194-003 | (Ma)* |
| CR10 | 1 | Diode, Silicon, LMZ6.2v, Zener 5.6v, 1 w, 10% | 12154-031 | SEMCOR |
| CR11 | 10 | Diode, Silicon, DP19-0 Power | 22194-000 | (ST)* IN2070 |
| CR12 | | Same as CR11 | | |
| CR13 | | Same as CR11 | | |
| CR14 | | Same as CR11 | | |
| CR15 | | Same as CR11 | | |
| CR16 | | Same as CR11 | | |
| CR17 | 3 | Diode, Silicon, 19-6, Power | 22194-006 | (ST) IN2071 |
| CR18 | | Same as CR17 | | |
| CR19 | | Same as CR17 | | |
| CR20 | | Same as CR11 | | |
| CR21 | | Same as CR11 | | |
| CR22 | | Same as CR11 | | |
| CR23 | | Same as CR11 | | |
| CR24 | 1 | Same as CR3 | | |
| F1 | 1 | Fuse, 5a, Fast Blow | 15470-000 | (Bu)* MTH-5 |
| L1 | 3 | Inductor, 15 μh, Phenolic core | 14284-000 | (Wi)* 1015-15-150 |
| L2 | | Same as L1 | | |
| L3 | | Same as L1 | | |
| L4 | 2 | Inductor, 25 μh, Phenolic core | 14284-001 | (Wi) 102-15-150 |
| L5 | | Same as L4 | | |
| L6 | 4 | Not Used | | |
| L7 | | Inductor, 1 μh Phenolic core | 14284-002 | (Wi) 205-11-10 |
| L8 | | Same as L7 | | |
| L9 | | Same as L7 | | |
| L10 | | Not Used | | |
| L11 | | Same as L7 | | |
| S1 | 1 | Switch, PB, Mom. Cont. 10a, 115v | 15300-000 | (Gr)* 2201 NO. |
| S2 | 1 | Switch, Toggle, SPST, 3a, 250v | 15280-000 | (AHH)* 20994-LH |

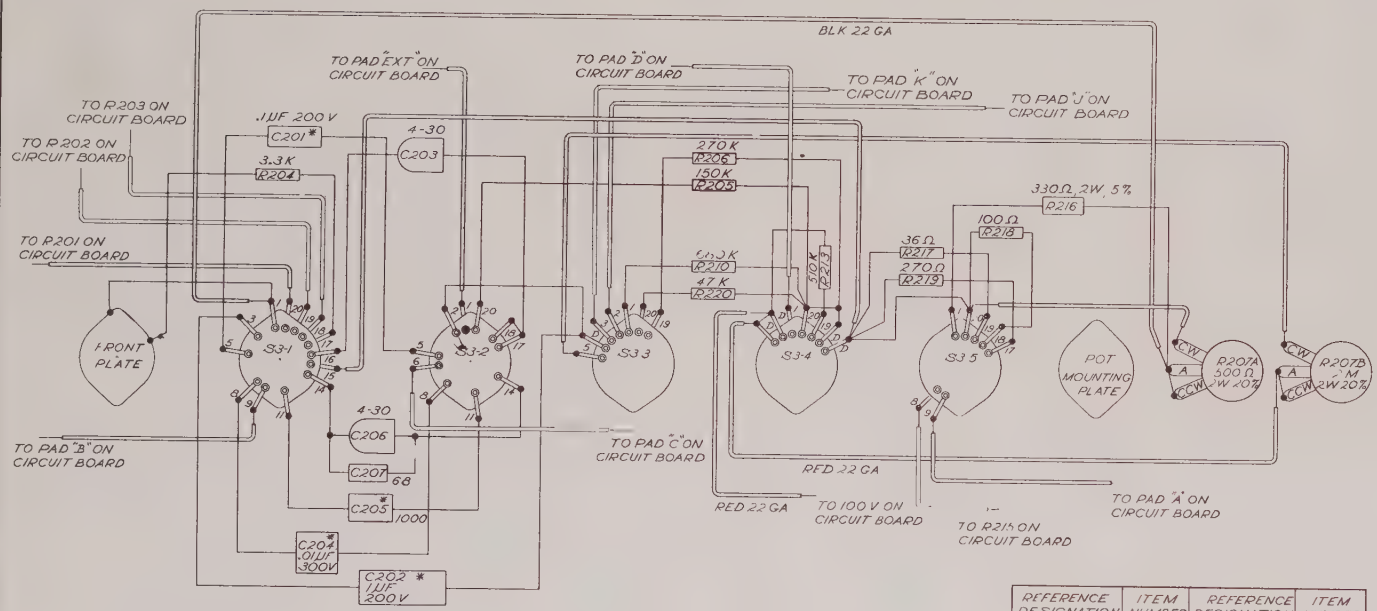
*-(MC)-Mag. Comp. - (TI)-Texas Instr. - (Sy)-Sylvania - (Ma)-Mallory - (GI)-Gen. Instr. - (ST)-Sarkes-Tarzian - (Bu)-Bussman - (Wi)-Wilco - (Gr)-Grayhill - AHH)-Arrow, Hart & Hegeman

**- DP19-0 may be substituted for DP19-1.

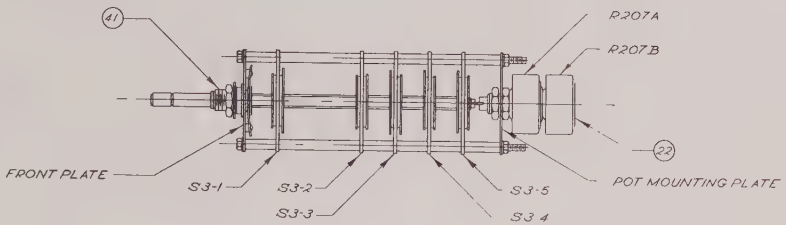
5.5 MISCELLANEOUS (Cont.)

| REF. NO. | QTY. USED | DESCRIPTION | DATAPULSE PART NO. | (MFR.) & MFR'S PART NO. |
|---|---|---|---|---|
| S3 | 1 | Switch, Oscillator Range | 37000-005 | (DpI)* |
| S4 | 1 | Switch, Delay | 37000-006 | (DpI) |
| S5 | 1 | Switch, Width | 37000-007 | (DpI) |
| S6 | 1 | Switch, Rotary, 3 position, 1 sec., 30°, conc., shorting | 25250-000 | (OM)* 218736-N1 |
| S7 | 1 | Switch, Rotary, 6 position, 1 sec., 60°, conc., shorting | 25250-001 | (OM) 218738-K1 |
| S8 | 1 | Switch, Rotary, 6 position, 1 sec., 60°, conc., shorting | 25250-002 | (OM) 218739-K1 |
| T1 | | | | |
| T2 | 1 | Transformer, Fil., F13X, 6.3v, .6a | 14050-000 | (Tr)* F13X |
| T3 | 3 | Transformer, Pulse, 1:1 Ratio | 37000-003 | (DpI) |
| T4 | | Same as T3 | | |
| T5 | | Same as T3 | | |
| T6 | 7 | Transformer, Pulse, 2:1 Ratio | 37000-004 | (DpI) |
| T7 | | Same as T6 | | |
| T8 | | Same as T6 | | |
| T9 | | Same as T6 | | |
| T10 | | Same as T6 | | |
| T11 | | Same as T6 | | |
| T12 | | Same as T6 | | |

*=(DpI)-Datapulse, Inc. - (OM)-Oak Mfg. - (Tr)-Triad




| REVISIONS | | | | |
|---|---|---|---|---|
| ECN | STAT | DESCRIPTION | DATE | APPROVAL |
| 1 | A | R216 IS 330Ω WAS 680Ω | 11Dec61 | E Fawcett |
| 16 | B | 1) DELETED R4, R202, R203, R208, R209, R212 R215<br>2) R207B IS 2M WAS 1.5M<br>3) R210 IS 680K WAS 620K | 9/20/62 | J.F.G.<br>E Burrell |




| REFERENCE DESIGNATION | ITEM NUMBER | REFERENCE DESIGNATION | ITEM NUMBER |
|---|---|---|---|
| | | C201 | 37 |
| | | C202 | 38 |
| | | C203 | 34 |
| R204 | 9 | C204 | 29 |
| R205 | 3 | C205 | 31 |
| R206 | 7 | C206 | 34 |
| R207A&B | 22 | C207 | 25 |
| R210 | 16 | | |
| R213 | 15 | | |
| R216 | 19 | | |
| R217 | 10 | | |
| R218 | 1 | | |
| R219 | 6 | | |
| R220 | 14 | | |

FOR PART REQIREMENTS SEE LIST OF MATERIAL 37000-005

| REQD | PART NO. | DESCRIPTION | ITEM |
|---|---|---|---|
| LIST OF MATERIALS | | | |

3. ALL CAPACITOR VALUES ARE IN UUF 500V 5%
2. ALL RESISTOR VALUES ARE ½ W 5%
1. * INDICATES COMPONENT VALUES MATCHED WITHIN 1% OF EACH OTHER.

NOTES: UNLESS OTHERWISE SPECIFIED

| 37000-005 | M-102 | / | / |
|---|---|---|---|
| NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY |
| APPLICATION | | QTY REQD | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON 2 PLACE DEC ± 3 PLACE DEC ± ANGLES ± MATERIAL FIN SH DO NOT SCALE DWG.

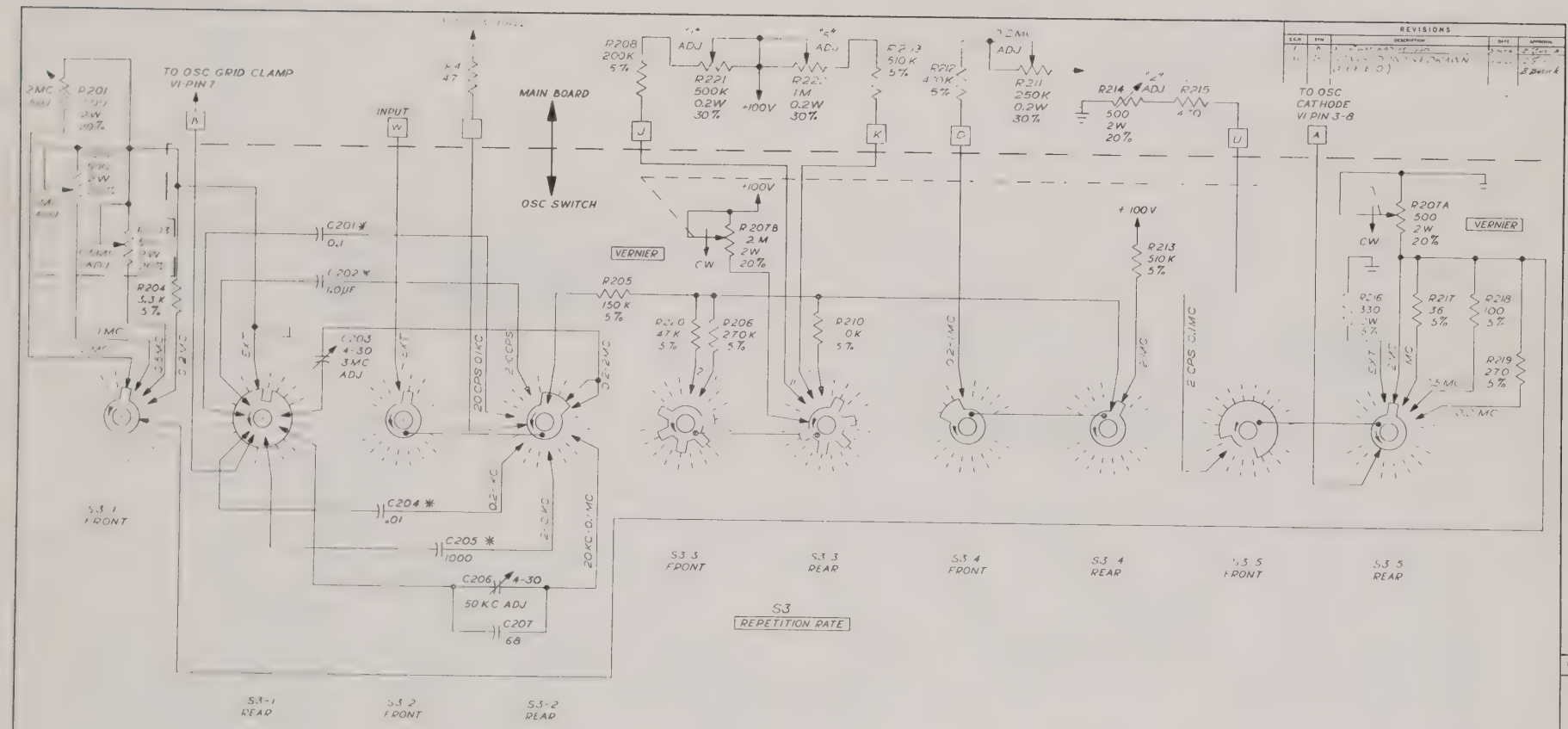
DRAWN C RANADOS 13 Sept 61
CHECKED D Fawcett 13 Sept 61
APPROVED Roy Stevens 16 Sept 61
APPROVED
APPROVED
RE-ISSUED E Burrell 8/15/62

TITLE: S3 ASSEMBLY - OSCILLATOR RANGE SWITCH
MODEL-102

DATAPULSE INC. INGLEWOOD CALIFORNIA

DWG SIZE D 37000-005
SCALE NONE
SHEET 1 OF 1

37000-005 B




* INDICATES COMPONENT VALUES MATCHED WITHIN 1% OF EACH OTHER.

9 ARROWS ON ROTOR BLADES INDICATE CW DIRECTION
8 NUMBERS AROUND ROTOR BLADES INDICATE KNOB SETTINGS FOR RESPECTIVE CONTACTS
7 ALL SWITCHES VIEWED FROM REAR
6. ROTOR BLADES OF SWITCH ARE SHOWN IN EXTREME CW POSITION (2MC)
5. BOXED LETTERS INDICATE SPECIFIC LABELED EYELETS ON CIRCUIT BOARD.
4 BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE.
3 A.. CAPACITOR VALUES LESS THAN ONE ARE IN UF
2 ALL CAPACITOR VALUES GREATER THAN ONE ARE IN MMF.
1. ALL RESISTOR VALUES ARE IN OHMS, ½W, 10%.

NOTES UNLESS OTHERWISE SPECIFIED

FOR PART REQUIREMENTS SEE LIST OF MATERIAL 37000-005

| REVISIONS | | | | |
|---|---|---|---|---|
| ECN | SYM | DESCRIPTION | DATE | APPROVAL |

| REQD | PART NO | DESCRIPTION | ITEM |
|---|---|---|---|
| | | LIST OF MATERIALS | |

| C201 | C207 | | 4400CF/000 | MHCA | | | |
|---|---|---|---|---|---|---|---|
| R201 | R207 | | | | | | |
| FIRST USED | LAST USED | OMITTED | NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY | |
| REFERENCE DESIGNATIONS | | | APPLICATION | | QTY REQD | | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON 3 PLACE DEC ± 2 PLACE DEC ± ANGLES ± MATERIAL FINISH DO NOT SCALE DWG.

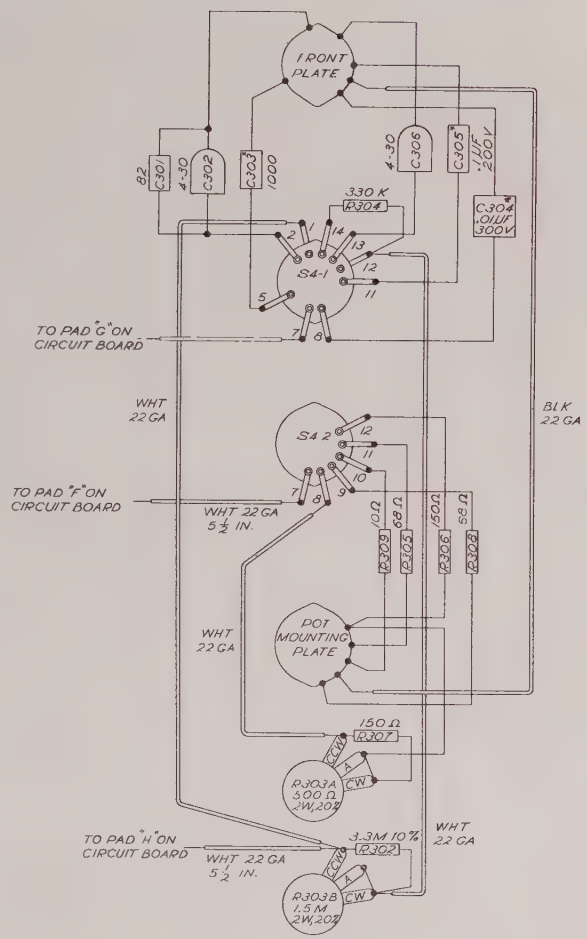
DRAWN G.PANADOS 1/16/64 CHECKED M. Lasker 30 mar 64 APPROVED APPROVED RELEASED

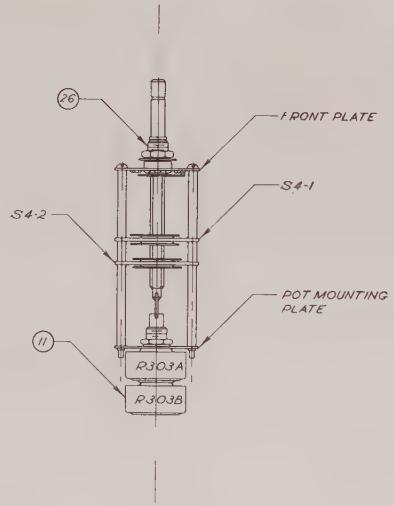
TITLE: SCHEMATIC 3MC OSCILLATOR SWITCH MODEL 102

DATAPULSE INC INGLEWOOD CALIFORNIA

SIZE D DWG 40000-001 SHEET 1 OF 1 SCALE NONE

40000-001 B




| REFERENCE DESIGNATION | ITEM NUMBER |
|---|---|
| R302 | 8 |
| R303A&B | 11 |
| R304 | 4 |
| R305 | 5 |
| R306 | 2 |
| R307 | 2 |
| R308 | 3 |
| R309 | 1 |
| C301 | 15 |
| C302 | 19 |
| C303 | 17 |
| C304 | 16 |
| C305 | 22 |
| C306 | 19 |

REVISIONS

| ECN | SYM | DESCRIPTION | DATE | APPROVAL |
|---|---|---|---|---|
| 4 | A | R308 IS 82 WAS 120 | 28 DEC 61 | B. Granados |
| 16 | B | DELETED R17 | | |
| 18 | C | 1) R308 IS 68 WAS 82<br>2) R309 IS 10 WAS 15 | 9/20/62 | J.G.<br>B. Granados |

3. ALL CAPACITOR VALUES ARE IN UUF 500V 5%.
2. ALL RESISTOR VALUES ARE ½W 5%.
1. * INDICATES COMPONENT VALUES MATCHED WITHIN 1% OF EACH OTHER.

NOTES: UNLESS OTHERWISE SPECIFIED

FOR PART REQUIREMENTS SEE LIST OF MATERIAL 37000-006

| REQD | PART NO. | DESCRIPTION | ITEM |
|---|---|---|---|
| | | LIST OF MATERIALS | |

| NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY |
|---|---|---|---|
| 37000 CCS | M-102 | 1 | |
| APPLICATION | | QTY REQD | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES OF
3 PLACE DEC. ± | 2 PLACE DEC ± | ANGLES ±
MATERIAL
FINISH
DO NOT SCALE DWG.

DRAWN GRANADOS 8 Sept 61
CHECKED
APPROVED
APPROVED
APPROVED
RELEASED

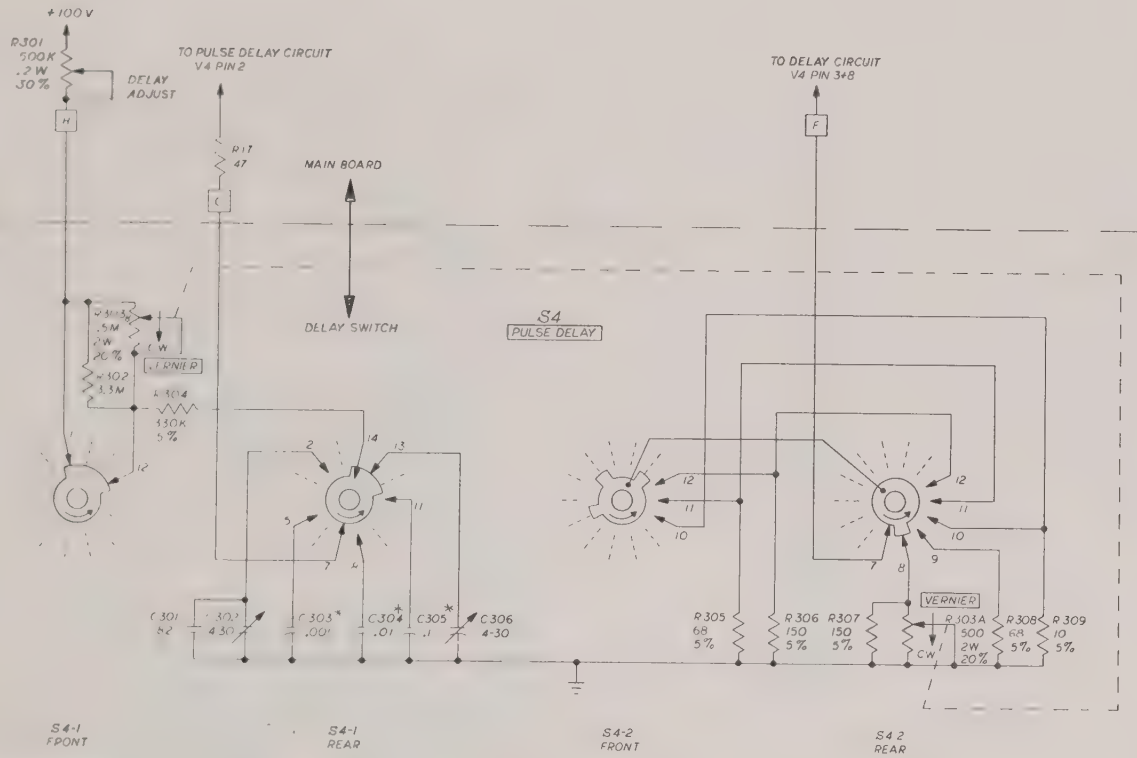
TITLE: S4 ASSEMBLY - PULSE DELAY SWITCH
MODEL-102
SCALE NONE

DATAPULSE
DATAPULSE, INC.
INGLEWOOD CALIFORNIA

DWG D 37000 006
SIZE
SHEET 1 OF 1

37000-006 C

| REVISIONS | | | | |
|---|---|---|---|---|
| ECR | STM | DESCRIPTION | DATE | APPROVAL |
| 4 | A | R308 IS 82 WAS 120 | 28 DEC 64 | F. Cusick |
| 16 | B | KIT MOVED TO MAIN CIRCUIT BOARD | | B. Leavitt |
| 19 | C | 1) R308 IS 68 WAS 82<br>2) R309 IS 10 WAS 15<br>3) R301 IS 500K WAS 250K | | E. Cusick |




* INDICATES COMPONENT VALUES MATCHED WITHIN 1% OF EACH OTHER.

FOR PART REQUIREMENTS SEE LIST OF MATERIAL 37000-006

8. NUMBERS SURROUNDING ROTOR BLADES INDICATE CONTACT NUMBERS.
7. ARROW ON ROTOR BLADE INDICATES CLOCKWISE ROTATION.
6. ROTOR BLADES OF SWITCH ARE SHOWN IN EXTREME CCW POSITION (0.5US).
5. BOXED LETTERS INDICATES SPECIFIC LABELED EYELETS ON CIRCUIT BOARD.
4. BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE.
3. ALL CAPACITOR VALUES LESS THAN ONE ARE IN μF.
2. ALL CAPACITOR VALUES GREATER THAN ONE ARE IN μμF.
1. ALL RESISTOR VALUES ARE IN OHM, ½W, 10%.

NOTES: UNLESS OTHERWISE SPECIFIED

LIST OF MATERIALS

| REQD | PART NO. | DESCRIPTION | ITEM |
|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| C301 | C306 | | H40000-000 M-102 | | |
| FIRST USED | LAST USED | OMITTED | NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY | QTY REQD |
| DESIGNATION | | | APPLICATION | | | | |

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES; TOLERANCES ON 3 PLACE DEC. ±, 2 PLACE DEC. ±, ANGLES ±; MATERIAL; FINISH; DO NOT SCALE DWG.

DRAWN: CRANADOS 1/16/67
CHECKED
APPROVED
APPROVED
APPROVED

TITLE: SCHEMATIC PULSE DELAY SWITCH

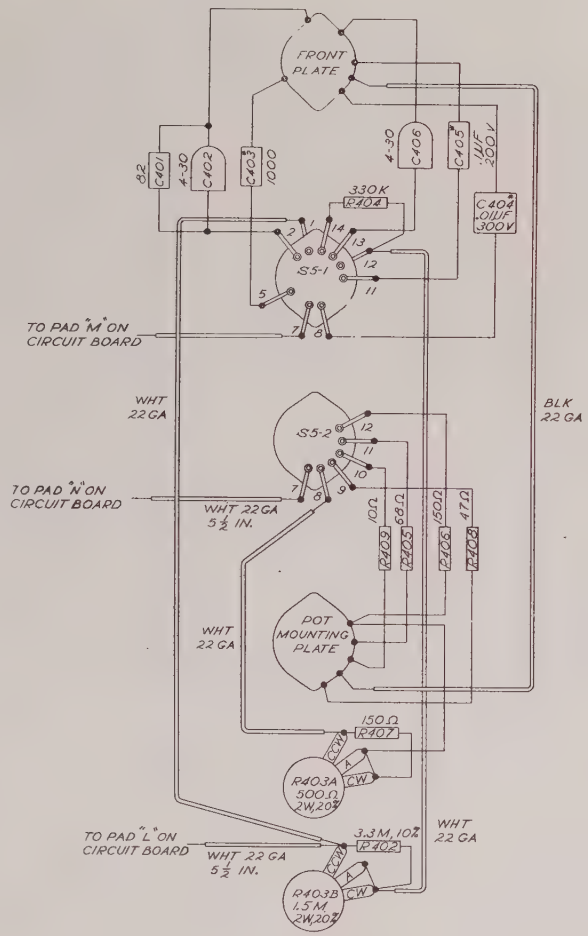
MODEL 102

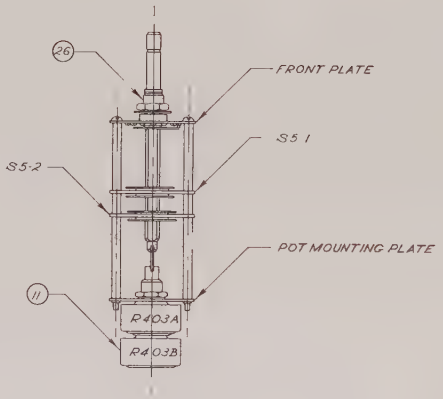
DATAPULSE INC. INGLEWOOD CALIFORNIA

DWG NO. 40000-002 REV C

SCALE NONE SHEET 1 OF 1

40000-002 C




| REFERENCE DESIGNATION | ITEM NUMBER |
|---|---|
| R402 | 8 |
| R403A&B | 11 |
| R404 | 4 |
| R405 | 5 |
| R406 | 2 |
| R407 | 2 |
| R408 | 3 |
| R409 | 1 |
| C401 | 15 |
| C402 | 19 |
| C403 | 17 |
| C404 | 16 |
| C405 | 22 |
| C406 | 19 |

REVISIONS

| E.C.N. | SYM | DESCRIPTION | DATE | APPROVAL |
|---|---|---|---|---|
| 4 | A | R408 IS 68 WAS 120 | 2/8/62 | B. Busick |
| 16 | B | DELETED R18 | 5/14/62 | J.F.G. |
| 18 | C | 1) R408 IS 47 WAS 68<br>2) R409 IS 10 WAS 15 | 9/20/62 | J.F.G.<br>B. Busick |

3. ALL CAPACITOR VALUES ARE IN μμF 500 V 5% .
2. ALL RESISTOR VALUES ARE ½ W 5% .
1. * INDICATES COMPONENT VALUES MATCHED WITHIN 1% OF EACH OTHER.

NOTES: UNLESS OTHERWISE SPECIFIED

FOR PART REQUIREMENTS SEE LIST OF MATERIAL 37000-007

| REQD | PART NO. | DESCRIPTION | ITEM |
|---|---|---|---|
| | | LIST OF MATERIALS | |

| 37000-009 | M-102 | | |
|---|---|---|---|
| NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY |
| APPLICATION | | QTY REQD | |

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES; TOLERANCES ON X PLACE DEC. ±, X PLACE DEC. ±, ANGLES ±; MATERIAL; FINISH; DO NOT SCALE DWG.

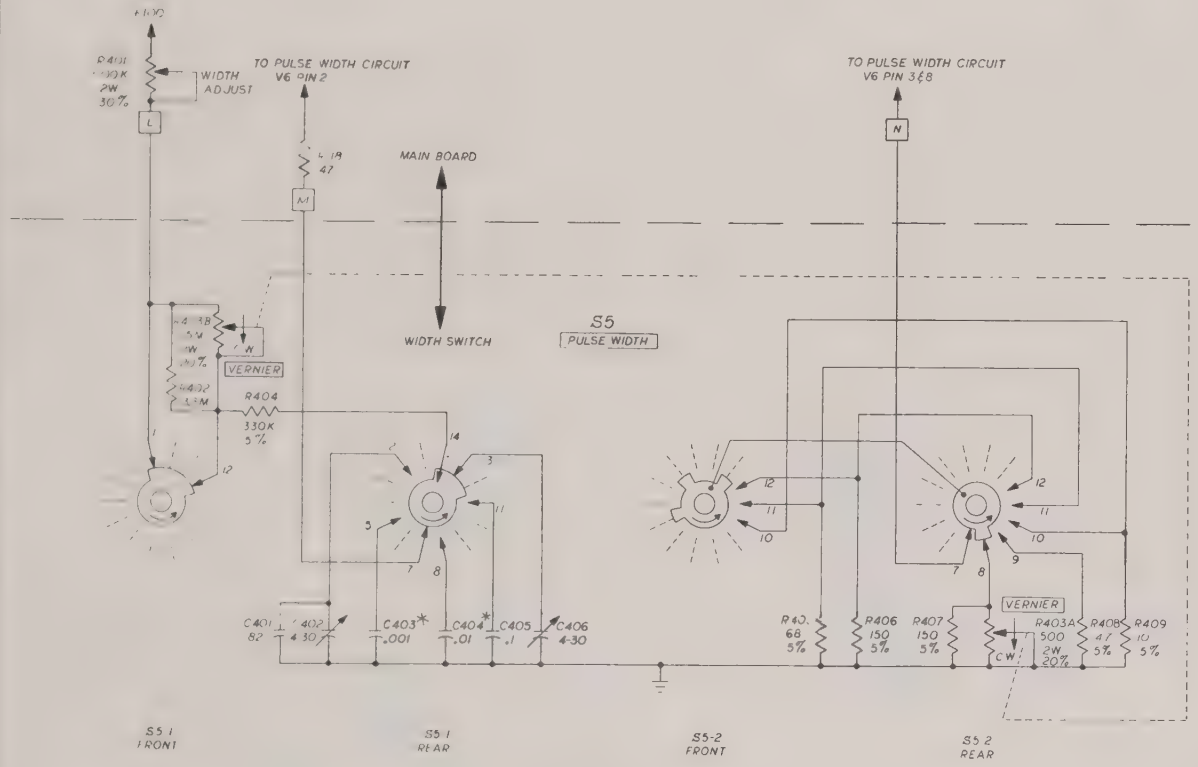
DRAWN: GRANADOS 11/5/62
CHECKED: B. Busick 11-5-62
APPROVED: M. J. Stroobants 11-5-62
APPROVED
APPROVED
RELEASED: B. Busick 11/5/62

TITLE: S5 ASSEMBLY - PULSE WIDTH SWITCH
MODEL 102
SCALE: NONE

DATAPULSE, INC. INGLEWOOD, CALIFORNIA

DWG SIZE: D — 37000-007
SHEET 1 OF 1

37000-007 C




* INDICATES COMPONENT VALUES MATCHED WITHIN 1% OF EACH OTHER.

8. NUMBERS SURROUNDING ROTOR BLADES INDICATE CONTACT NUMBERS.
7. ARROW ON ROTOR BLADE INDICATES CLOCKWISE ROTATION.
6. ROTOR BLADES OF SWITCH ARE SHOWN IN EXTREME CCW POSITION (.5US).
5. BOXED LETTERS INDICATE SPECIFIC LABELED EYELETS ON CIRCUIT BOARD.
4. BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE.
3. ALL CAPACITOR VALUES LESS THAN ONE ARE IN μF.
2. ALL CAPACITOR VALUES GREATER THAN ONE ARE IN μμF.
1. ALL RESISTOR VALUES ARE IN OHMS ½W, 10%

NOTES: UNLESS OTHERWISE SPECIFIED

FOR PART REQUIREMENTS SEE LIST OF MATERIAL 37000-007

REVISIONS

| LTR | ETM | DESCRIPTION | DATE | APPROVAL |
|---|---|---|---|---|
| A | A | R408 IS 68 WAS 120 | 11 Oct 61 | |
| B | B | MOVED PAD (M) TO MAIN CIRCUIT BOARD | | |
| C | C | 1) R408 IS 47 WAS 68 2) R409 IS 10 WAS 15 3) R401 IS 500K WAS 250 | | |

| PIECE | PART NO | DESCRIPTION | ITEM |
|---|---|---|---|

LIST OF MATERIALS

| C401 | C406 | | H40000 000 | M-102 | | | |
|---|---|---|---|---|---|---|---|
| R401 | R409 | | | | | | |
| FIRST USED | LAST USED | CM/ETT | ASSOCIATED DRAWING | USED ON | NEXT ASSY | FINAL ASSY | QTY REQD |
| REFERENCE DESIGNATION | | | APPLICATION | | | | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
3 PLACE DEC. ± | 2 PLACE DEC. ± | ANGLES ±
MATERIAL
FINISH
DO NOT SCALE DWG.

DRAWN G.D'ANADOS 11/16/61
CHECKED B. Estelle 16 Nov 61
APPROVED
APPROVED
APPROVED
RELEASED
SCALE NONE

TITLE
SCHEMATIC — PULSE WIDTH SWITCH
MODEL 102

DATAPULSE INC.
INGLEWOOD CALIFORNIA

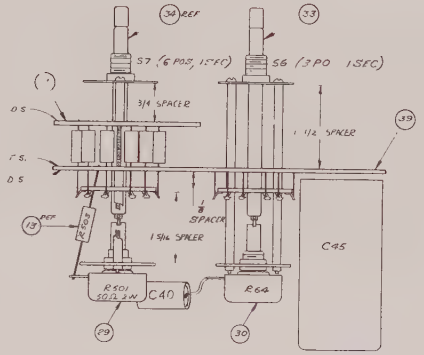
DWG SIZE D
40000-003
SHEET OF

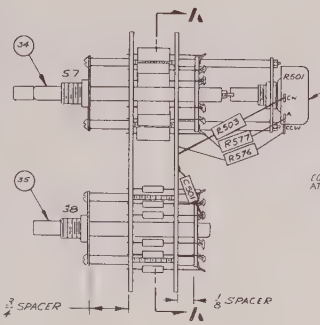
40000-003 C

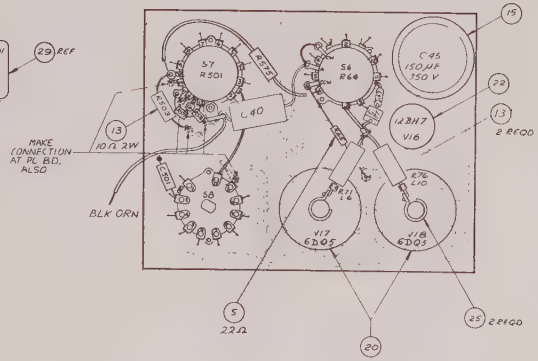
| REVISIONS | | | | |
|---|---|---|---|---|
| E.C.N. | SYM | DESCRIPTION | DATE | APPROVAL |
| 4 | A | ADDED R575, R576, R577, R146<br>ADDED C73, C74, C75, C76, C501 | 28 OCT 61 | B. Basich |
| 15 | B | 1) DELETED C73, 74, 75 & 76<br>R146, L6, L10<br>2) ADDED C40, R147, C77<br>3) R71 & 76 ARE 10Ω<br>WERE 150 Ω<br>4) ADDED (2) EF ADG AT<br>PL. AT E OF V17 & V18<br>5) ADDED BEAD AT<br>JUNCTION OF C40 & R64 | 1/21<br>5-1-<br>8 | B. Basich |

| REF DES | ITEM NO | VALUE |
|---|---|---|
| R516 | 9 | 15Ω 1W |
| R517 | 9 | 15Ω 1W |
| R524 | 10 | 3.6Ω 1W |
| R525 | 10 | |
| R530 | 10 | |
| R531 | 10 | |
| R535 | 10 | |
| R536 | 10 | |
| R540 | 10 | |
| R541 | 10 | 5.6Ω 1W |
| R546 | 9 | 36Ω 2W 5% |
| R550 | 7 | 36Ω 2W 5% |
| R563 | 3 | 36Ω 2W 5% |
| R564 | 1 | 36Ω 1/2W 5% |
| R566 | 1 | |
| R567 | 1 | |
| R569 | 1 | |
| R570 | 1 | |
| R572 | 1 | |
| R573 | 1 | 36Ω 1/2W 5% |
| R575 | 11 | 2.7Ω 1W |
| R576 | 11 | 2.7Ω 1W |
| R577 | 11 | 2.7Ω 1W |
| C77 | 18 | .27 MF 600V 5% |
| C501 | 17 | 10 MF 25 V |
| R71 | 13 | 10Ω, 2W, 10% |
| R76 | 13 | 10Ω, 2W, 10% |
| R147 | 4 | 100Ω, 1/2W, 10% |

SECTION AA




2. ALL CAPACITOR VALUES ARE IN μμF 500V 5%
1. ALL RESISTOR VALUES ARE ½ W 10%

NOTES: UNLESS OTHERWISE SPECIFIED.

| REQD | PART NO. | DESCRIPTION | ITEM |
|---|---|---|---|
| LIST OF MATERIALS | | | |

| | | | |
|---|---|---|---|
| MODEL 102 | | | |
| NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY |
| APPLICATION | | QTY REQD | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PLACE DEC ± | 3 PLACE DEC ± | ANGLES ±
MATERIAL
FINISH
DO NOT SCALE DWG.

| | | |
|---|---|---|
| DRAWN | R.A. SPENCER | 8/23/61 |
| CHECKED | [illegible] | [illegible] |
| APPROVED | [illegible] | 2/6/62 |
| APPROVED | | |
| APPROVED | | |
| RELEASED | [illegible] | 2/22/62 |

TITLE: ASSEMBLY- ATTENUATOR AND OUTPUT AMPLIFIER

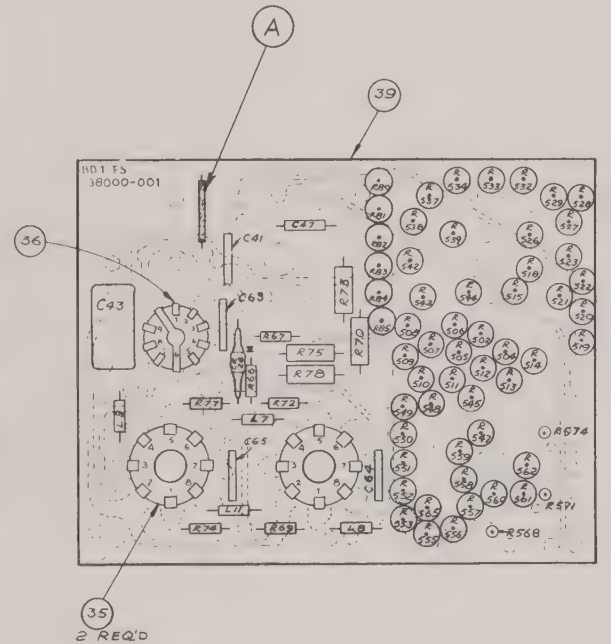
DATAPULSE, INC. INGLEWOOD, CALIFORNIA

SCALE 1:1 | DWG D | SIZE | 37000-000 | SHEET 1 OF 1

37000-000 B

| REVISIONS | | | | |
|---|---|---|---|---|
| E.C.N | SYM | DESCRIPTION | DATE | APPROVAL |
| 4 | A | REPLACED R79 10Ω 2W WITH A JUMPER | 28 DEC 61 | B Busick |
| 16 | B | R507 THRU R514 FROM 2.7K TO 10K | 24 SEP 62 | B. Busick |

| REFERENCE | ITEM NO. | VALUE | REF. DES. | ITEM NO. | VALUE |
|---|---|---|---|---|---|
| R1 | 8 | 1/4 W 10% | C1 | 2 | 390Ω 2W 5% |
| R2 | 7 | 100K | C2 | | |
| R3 | 6 | 100Ω | C3 | | |
| R4 | 11 | 2.7K 1W | C4 | | |
| R5 | 6 | 100Ω | C5 | | |
| R6 | 11 | 2.7K 1W | C6 | | |
| R7 | 6 | 100Ω | C7 | 2 | 390Ω 2W 5% |
| R8 | 6 | 100Ω | C8 | 3 | 47Ω 2W 5% |
| R9 | 11 | 2.7K 1W | C9 | 1 | 47Ω 5% |
| | | | C10 | 1 | 47Ω 5% |
| R11 | 17 | 100Ω 2W | C11 | 1 | 47Ω 5% |
| R12 | | 100Ω 2W | | | |
| R13 | | | | | |
| R14 | | | | | |
| R15 | 17 | 100Ω 2W | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | 100Ω 2W | | | |
| R19 | 18 | 100Ω 2W | | | |
| R20 | 15 | 100Ω 2W | C41 | 28 | .01UF +80% -20% 500V |
| R21 | 15 | 100Ω 2W | C42 | 27 | 1UF 400V 10% |
| R22 | 19 | 10K 2W | C43 | 26 | 220 |
| R23 | | | | | |
| R24 | | | C63 | 28 | .01UF +80% -20% |
| R25 | | | C64 | 28 | .01UF +80% -20% |
| R26 | | | C65 | 28 | .01UF +80% -20% |
| R27 | | | | | |
| R28 | 19 | 10K 2W | | | |
| R29 | 18 | 100Ω 2W | | | |
| R30 | 16 | 1K 2W | CR24 | 29 | IN34A |
| R31 | 16 | 1K 2W | | | |
| R32 | 16 | 1K 2W | | | |
| R503 | 16 | 1.5K 2W | | | |
| R506 | 18 | 100Ω 2W | | | |
| R507 | 23 | 330Ω 2W | L7 | 32 | 1UH |
| R508 | 23 | 330Ω 2W | L8 | 32 | 1UH |
| R509 | 23 | 330Ω 2W | L9 | 32 | 1UH |
| R536 | 24 | 680Ω 2W | L11 | 32 | 1UH |
| R533 | | | | | |
| R534 | | | | | |
| R537 | | | | | |
| R538 | | | | | |
| R539 | | | | | |
| R542 | | | | | |
| R543 | | | | | |
| R544 | 22 | 680Ω 2W | | | |
| R545 | 4 | 10Ω 2W 5% | | | |
| R547 | | | | | |
| R548 | | | | | |
| R549 | | | | | |
| R550 | | | | | |
| R551 | | | | | |
| R552 | | | | | |
| R553 | 4 | 10Ω 2W 5% | | | |




FOR PART REQUIREMENTS REFER TO LM 37000-001

| REQD | PART NO. | DESCRIPTION | ITEM |
|---|---|---|---|
| | | LIST OF MATERIALS | |

2. ALL CAPACITOR VALUES ARE IN UUF 500V 5%
1. ALL RESISTOR VALUES ARE ½ W 10%

NOTES: UNLESS OTHERWISE SPECIFIED:

| 370CO-00C MODEL 102,104 | 1 | 1 |
|---|---|---|
| NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY |
| APPLICATION | | QTY REQD | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
3 PLACE DEC. ± | 2 PLACE DEC. ± | ANGLES ±
MATERIAL
FINISH
DO NOT SCALE DWG.

| | | |
|---|---|---|
| DRAWN | W. A. STOFKOOPER | 8/29/61 |
| CHECKED | B Busick | 29 AUG 61 |
| APPROVED | M. Strom | 9/2/61 |
| APPROVED | | |
| APPROVED | | |
| RELEASED | B Busick | 24 SEP 62 |

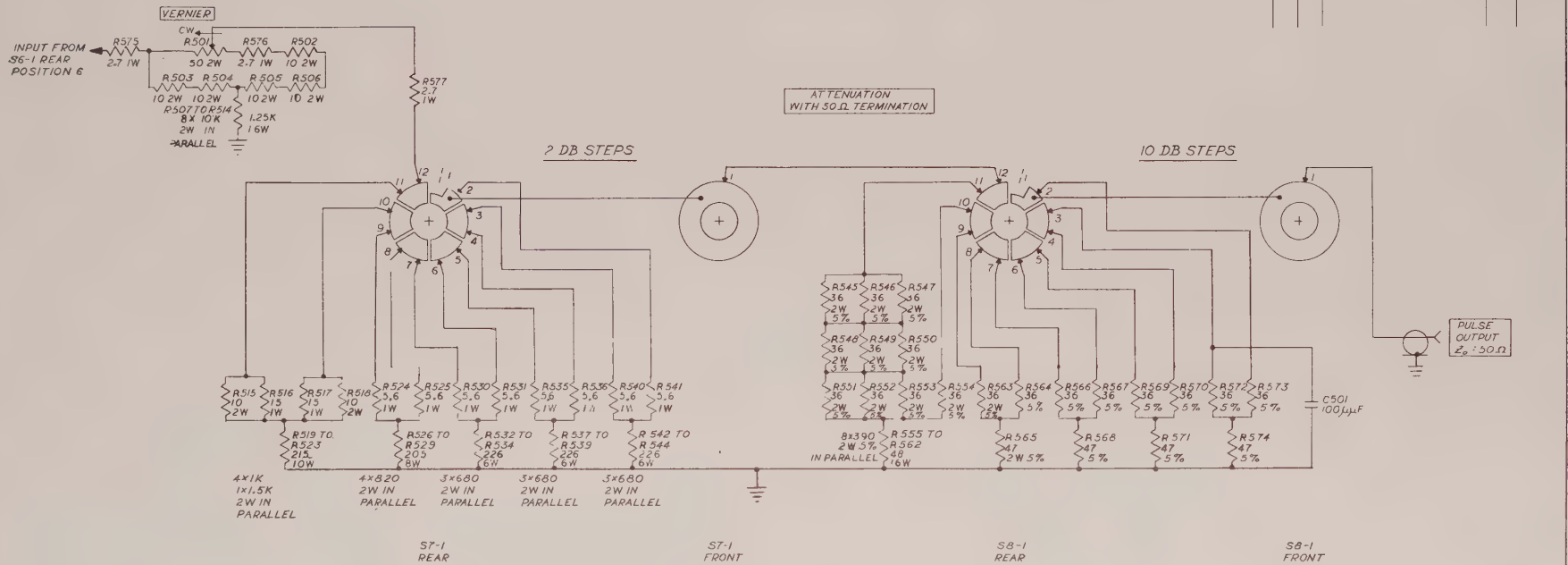
TITLE
SUB ASSEMBLY - BOARD NO 1
ATTENUATOR AND OUTPUT AMPLIFIER

DATAPULSE
DATAPULSE, INC.
INGLEWOOD, CALIFORNIA

DWG 37000-001
SIZE C
SCALE 1 / 1
SHEET 1 OF 1

B
37000-001

| REVISIONS | | | | |
|---|---|---|---|---|
| E.C.N. | DTR | DESCRIPTION | DATE | APPROVAL |
| 4 | A | R575,576,577 (2.7 1W) ADDED C501 (100μμF) ADDED | 28 DEC 61 | B. Butler |
| 16 | B | R507 THRU R514 FROM 2.7K TO 10K; FROM 338Ω 16W TO 1.25K | 24 SEP 62 | B Butler |




40000-004 B

FOR PART REQUIREMENTS SEE LIST OF MATERIAL 37000-000

| QTY REQD | PART NO | DESCRIPTION | ITEM |
|---|---|---|---|
| LIST OF MATERIALS | | | |

2. ROTOR BLADES OF SWITCHES ARE SHOWN IN EXTREME CCW POSITION AS VIEWED FROM CONTROL KNOB
1. ALL RESISTOR VALUES ARE IN OHMS, ½ W, 10%

NOTES: UNLESS OTHERWISE SPECIFIED

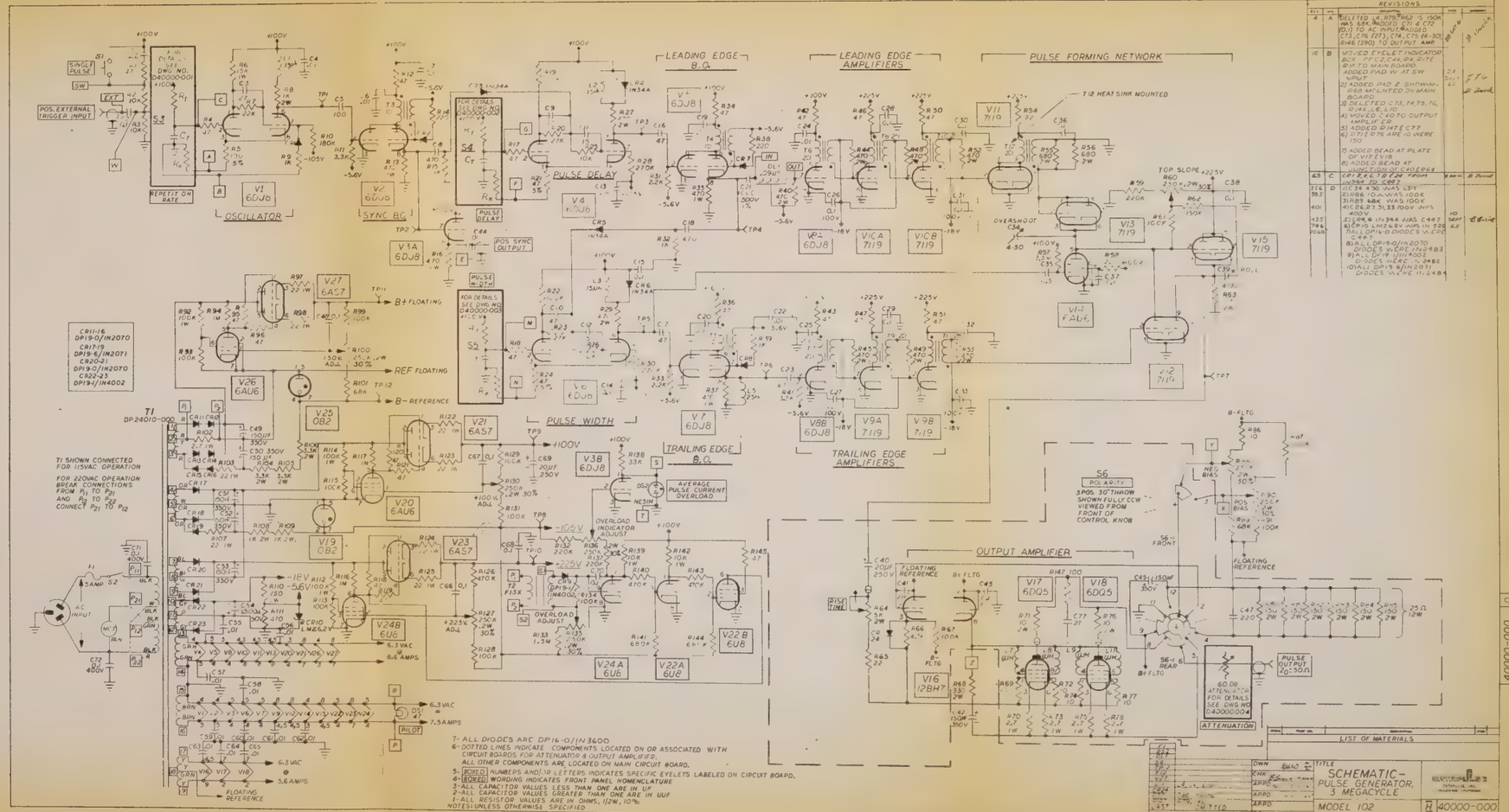
| C501 R501 | C501 R577 | | 40000-000 | M102 | |
|---|---|---|---|---|---|
| FIRST USED | LAST USED | OMITTED | ASSOCIATED DWG | USED ON | NEXT ASSY |
| REFERENCE DESIGNATION | | | APPLICATION | | QTY REQD |

| | | |
|---|---|---|
| DRAWN | 11/16/61 | TITLE SCHEMATIC ATTENUATOR 60DB 10W 10% |
| CHK B BUTLER | 11/16/61 | |
| APPD W.I. JOHNSON | 12/5/61 | |
| APPD M.I. JOHNSON | 12/5/61 | |
| RELEASED B BUTLER | 12/5/61 | |

DATAPULSE INC. INGLEWOOD, CALIFORNIA

SIZE D | DWG 40000-004

SCALE NONE | SHEET 1 OF 1


SINGLE PULSE
SW
EXT
POS. EXTERNAL TRIGGER INPUT
REPETITION RATE
OSCILLATOR
SYNC BC
PULSE DELAY
LEADING EDGE B.O.
LEADING EDGE AMPLIFIERS
PULSE FORMING NETWORK
TOP SLOPE
OVERSHOOT
PULSE WIDTH
TRAILING EDGE B.O.
TRAILING EDGE AMPLIFIERS
OUTPUT AMPLIFIER
B+ FLOATING
REF FLOATING
B- REFERENCE
FLOATING REFERENCE
AVERAGE PULSE CURRENT OVERLOAD
OVERLOAD INDICATOR ADJUST
OVERLOAD ADJUST
POS SYNC OUTPUT
PULSE OUTPUT Zo=50Ω
60 DB ATTENUATOR
ATTENUATION
AC INPUT
PILOT
T1 SHOWN CONNECTED FOR 115VAC OPERATION
FOR 220VAC OPERATION BREAK CONNECTIONS FROM P21 TO P21 AND P22 TO P23 CONNECT P21 TO P12
S6 POLARITY 3POS 30° THROW SHOWN FULLY CCW VIEWED FROM FRONT OF CONTROL KNOB
REVISIONS
LIST OF MATERIALS
SCHEMATIC- PULSE GENERATOR, 3 MEGACYCLE
MODEL 102
40000-000

# SQUARE WAVE GENERATION AND HIGH CURRENT OUTPUT

Square Wave Generation:

The Model 102 pulse generator is specified for performance when working into a 50Ω load, with power supplies adjusted to provide an output of 50 volts peak amplitude at average currents up to 225 mA. This, in effect, limits the output pulse width duty cycle to 22.5% when working with a 50Ω load. This duty cycle limitation cannot be extended, as would appear at first glance, by reducing the output amplitude by means of the instrument's attenuation controls, since output amplitude is reduced (including fill-in between steps) by a constant impedance attenuator which leaves the instrument generating its full output but simply drains off a portion of this output through the attenuator before reaching the output jack. Some applications, such as frequency response testing by pulse or square wave techniques and gating applications, require pulse width duty cycles in excess of this 22.5% limitation. Many of these requirements can be met through inherent capabilities of the instrument when operating into higher impedance loads, or, in some cases, by readjusting certain instrument power supply voltages, detailed as follows.

Generating square waves into high impedance loads: The standard instrument, unmodified and as normally adjusted by the factory, can provide positive going square waves up to 70 volts peak-to-peak amplitude into loads of 800Ω and higher. When operating in this fashion, the minimum fall time (trailing edge transition time) is increased to approximately 0.1 μsec, rise time must usually be deteriorated to at least 15 nsec. for maintenance of clean waveform, maximum repetition rate for square wave generation is approximately 1.5 mc, and care must be taken to drive the load through a short cable or line with characteristic impedance approximately the same as load impedance. When operating in this mode, the internal attenuation may not be used for amplitude control as its Z of 50Ω will cause the instrument to go into overload protection. For amplitude control, a circuit such as shown below is necessary:

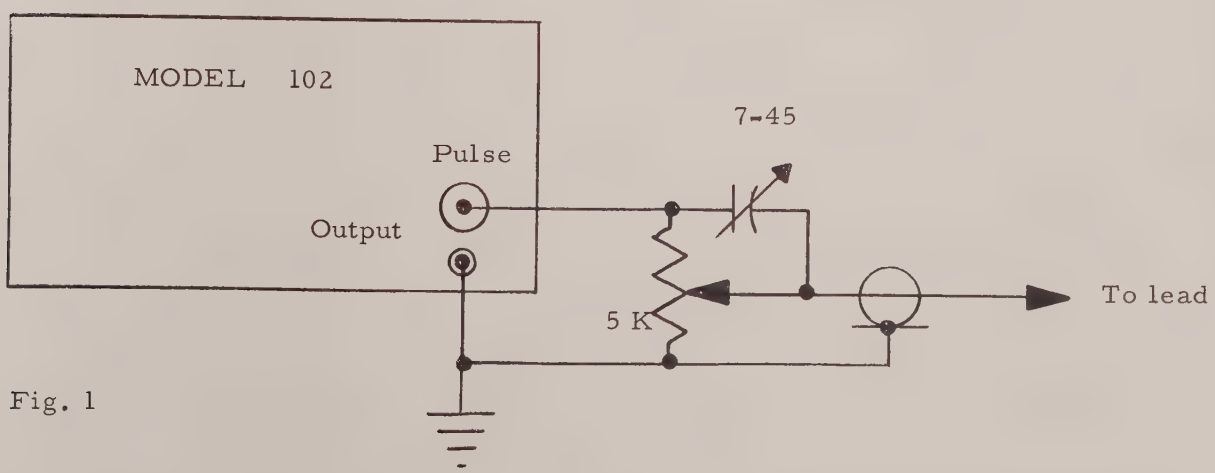



Fig. 1

Square wave generation into a 50Ω load: 50% (square wave) and even higher pulse output duty cycles may be achieved with the Model 102, into a 50Ω load, by utilizing adjustment potentiometers provided to decrease the +225 volt power supply output to +150 volts and the 150 volt supply output to 115 volts. Instructions for adjusting these power supplies, and location of the adjustments, may be found in the Instruction Manual (although those instructions do not contemplate this readjustment specified above). It will also be necessary to adjust positive output bias (R90) such that instrument is not in an overload condition. One may find it necessary to adjust top slope (R60) on wide pulses. With the power supplies readjusted in this fashion, the instrument can provide a positive going square wave of approximately 15 volts amplitude peak-to-peak, into a 50Ω load, at repetition rates to be at least 1 mc. Also, at this setting, outputs of decreased amplitude can be secured at even higher pulse width duty cycles, up to 10 volts into 50Ω at 80% pulse width duty cycle, at repetition rates below 1 mc.

The above detailed readjustments decrease the pulse amplitude generated by the instrument's pulse forming circuitry preceding the output stage to the point where the overload circuitry, which operates on the +225 voltage under overload conditions, does not cut in and out (to hold the output within its 225 mA limitation), thereby producing the apparent pulse amplitude jitter in the nonreadjusted unit.

High Current Output Into Low Impedance Loads:

When operating into a 50Ω load, the Model 102 provides slightly in excess of 1 ampere of peak output current. Certain applications, such as magnetic device evaluation or drive of many paralleled digital circuits, require higher output current into lower impedance loads. The standard instrument, without modification or readjustment of internal controls, will provide up to ± 15 volts into a 10Ω load, or 1.5 amperes peak. This performance may be achieved up to pulse width duty cycles of approximately 4%, with operation stable at correspondingly reduced amplitude (due to action of overload circuitry) up to pulse width duty cycles of approximately 10%. For best waveform, it will be found necessary to deteriorate the rise time to 12 to 14 nsec. and to readjust the internal flat top adjustment.

The procedure, as given above, for square wave generation into a 50Ω load applies for positive polarity only. Since the negative output driver is operated as an inverting amplifier, negative amplitude may not be reduced sufficiently by internal adjustment to permit 50% duty cycle without producing an overload condition. The overload adjust (R135)and overload indicator adjust (R136) settings must not be changed for any reason.

# MULTIPLE PULSE GENERATION WITH MODEL 102 PULSE GENERATORS

Magnetic device testing, beacon development, and digital or other pulse code simulation often require multiple pulse or pulse train signals. Such applications need not require costly special purpose gear. Multiple DATAPULSE 102 Pulse Generators, properly connected, will satisfy a broad range of requirements.

Advantages of this method include: (1) lower cost--several 102's cost far less than a comparable special purpose unit; (2) greater versatility -- such a combination can be broken down into individual units for use on other projects; and (3) greater dependability -- unlike complex special purpose equipment, the 102 is simple, proven, and easily operated. In addition, individual control of all pulse parameters is available when using several 102's, and all pulses are selectable in polarity and amplitude, a feature not always available on expensive multi-pulse generators. Also, output power available is greater than in most special units.

## OUTPUTS ON SEPARATE LINES

Connection as shown in Figure 1 is simple and effective and permits flexible control of the pulses. Repetition rate controls on Generators No. 2 and No. 3 are placed on EXTERNAL. Repetition rate is controlled from Generator No. 1. Pulse delay, width, polarity, amplitude and rise time are independently controlled over the normal range by the controls of the generator associated with that pulse.

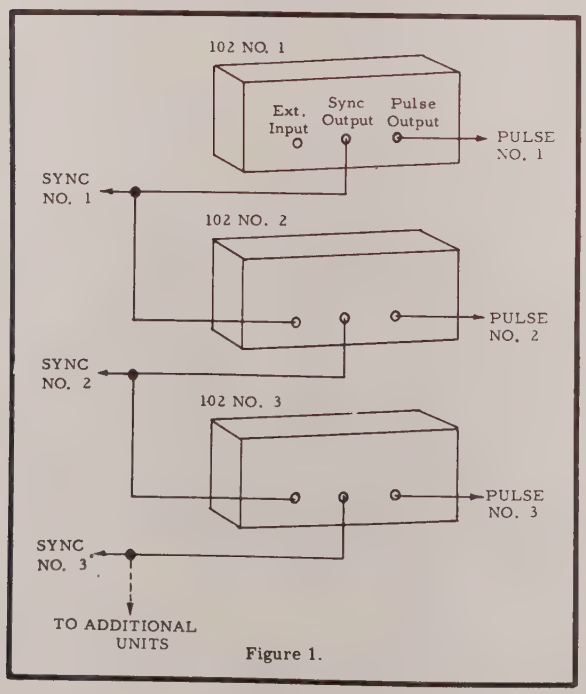


Figure 1.

Figure 2 presents the time relationships for the outputs when three 102's are connected together as in Figure 1. Note, that a nominal 15 nanosecond delay exists between sync outputs.

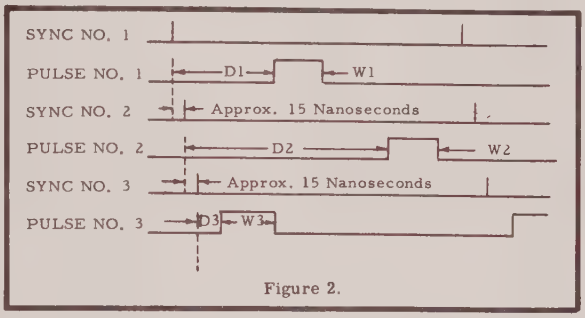


Figure 2.

## OUTPUT ON A SINGLE LINE

For single line output, the outputs of the 102's may be mixed using coaxial tees as shown in Figure 3. The generators may be driven separately or in parallel from external sources or driven in tandem using the sync output of one generator to externally drive the next. Generator No. 1 (Fig. 3) also may be driven by an outside source in this arrangement, if sync with outside phenomena is desired.

Because of the fast rise character of the pulses and narrow widths available, pulse repetition rates exceeding 10 mc may be synthesized (see Figure 13).

Output waveform with this connection is a function of termination of interconnecting cables. With improper termination, reflections occur which cause wave shape deterioration and increased rise time. Several methods of mixing with results obtained are discussed below.

## MIXING METHODS

The method shown in Figure 3 provides the greatest pulse amplitude, but due to cable mismatching, considerable waveform distortion, particularly overshoot on positive pulses, may present itself. Also, minimum rise times may be increased by a factor of two or more, depending on length of connecting cables. Results of this method are shown in Figures 5a and 5b.

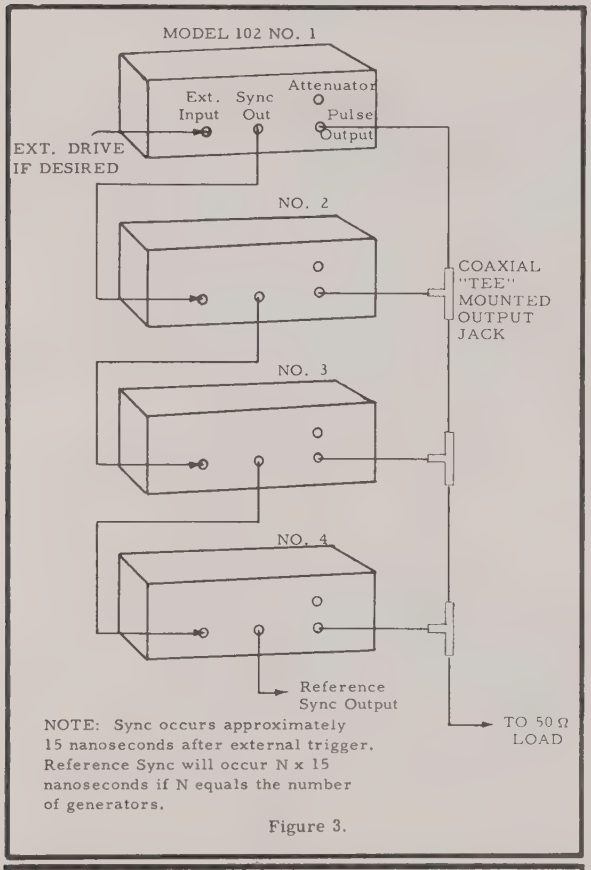
The use of a mixing pad, as shown in Figure 4, has been suggested, but is not satisfactory. Although this method does reduce overshoot, it is accompanied by considerable leading and lagging edge distortion, as shown in Figures 6a and 6b.

Best results in the area of waveform fidelity are obtained by inserting some measure of attenuation (the amount varying with the number of generators) at the generator end by using the internal attenuator.

(CONTINUED)

With a characteristic impedance of 50 ohms, the internal attenuator tends to terminate the connecting cable, yielding much less waveform distortion. Of course, this is accomplished at the expense of less amplitude. Figures 7a and 7b show the effect of 2 db attenuation; Figures 8a and 8b show the effect of 4 db.

Figures 9 - 13 show waveform possibilities with three generators each set at 6 db. Tektronix 581 with Type "L" plug-in (7 nanoseconds rated rise) was used.




NOTE: Sync occurs approximately 15 nanoseconds after external trigger. Reference Sync will occur N x 15 nanoseconds if N equals the number of generators.

Figure 3.

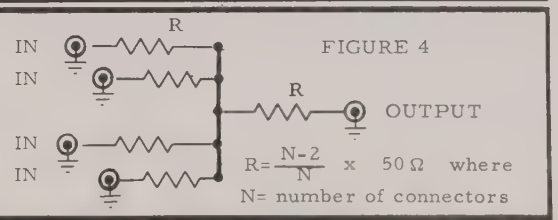
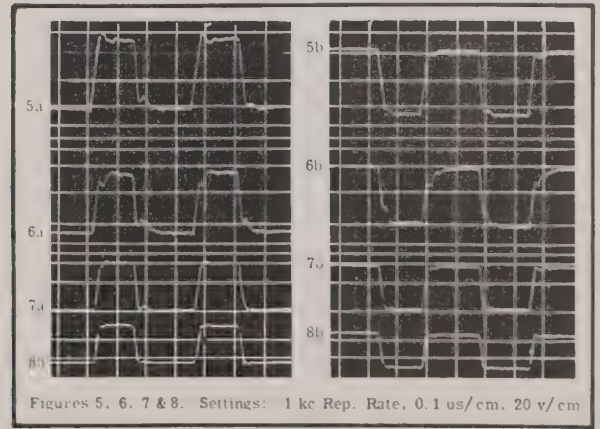



FIGURE 4




Figures 5, 6, 7 & 8. Settings: 1 kc Rep. Rate, 0.1 us/cm, 20 v/cm

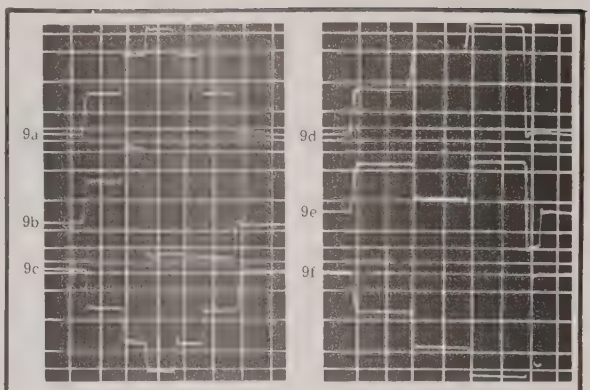



Figure 9. Three Superimposed Pulses.
Settings: 1 kc Rep. Rate, 0.2 us/cm, 10 v/cm.

9a: Three Pos. Pulses
9b: Two Pos. and One Neg
9c: Three Neg. Pulses
9d: Three Pos. in Staircase Array
9e: Two Pos. and One Neg.
9f: Three Neg. in Staircase Array

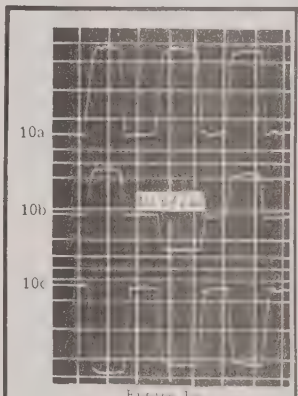



Figure 10.
Three Pulses (not superimposed)
Settings: 1 kc Rep. Rate, 0.1 us/cm, 5 v/cm.

10a: Three Pos. Pulses Approx. 0.1 us wide
10b: Two Pos. and One Neg
10c: Three Neg. Pulses Approx 0.1 us wide

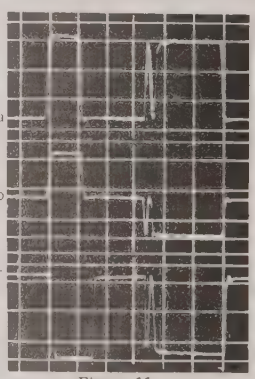



Figure 11.
Variations in Coding
Settings: 1 kc Rep. Rate, 0.2 us/cm, 5v/cm.

11a: Three Pos. Pulses -- Two wide, one narrow with very little separation between the two.
11b: One Pos. and Two Neg.
11c: Three Neg. Pulses.

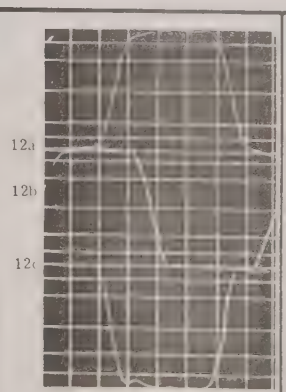



Figure 12
Rise and Fall Time of Various Pulse Configurations
Setting: 0.02 us/cm
12a: One Pos. Pulse
12b: Pos. and Neg. Pulses Lagging and Leading Coincident
12c: One Neg. Pulse

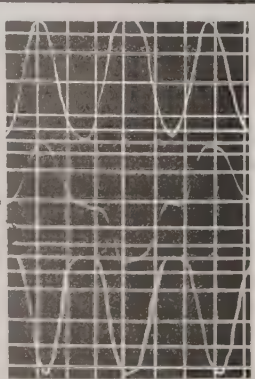



Figure 13.
High Rep. Rate Synthesis
Setting: 0.02 us/cm
13a: Three Pos. Pulses.
13b: Two Pos. and One Neg.
13c: Three Neg. Pulses.

# MODEL 102 OVERLOAD PROTECTION

Specifications of the Model 102 Pulse Generator lead to the expectation of 22.5% pulse width duty cycle capability at maximum output amplitude (output of 50 V peak into 50 ohms and 225 ma maximum average output current). However, the positive pulse baseline specification of "less than 0.5 V" is a steady drain of 10 ma and it will be found that output amplitude exceeds 50 V sufficiently to decrease the actual duty cycle capability to 18 to 20%.

Note also that decreasing the output amplitude does not increase the pulse width duty cycle capability, since the output amplitude is reduced by a constant impedance output attenuator, which leaves the instrument always producing the same output power and simply drains off a part of this power.

When the duty cycle capability of the instrument is exceeded, control circuitry takes over to reduce the amplitude of a large enough percentage of output pulses to bring the average current down to 225 ma. This results in an apparent amplitude jitter (due to the sampling and correcting action) when the unit is in an overload condition, which does not allow operation at excessive duty cycle with stably decreased amplitude. (For information on operation at extended duty cycles to 50% and higher, see Applications Bulletin No. 102-1).

The overload indicator is activated by the overload protection circuitry, up to pulse width duty cycles where the unit's pulse width control circuitry fails (somewhere past 70% duty cycle). Beyond this point, the overload protection circuitry no longer operates since the drive signal to the output stage is skipping, low in amplitude, or missing entirely and the unit is therefore not trying to pass more than its rated 225 ma through the output stage. In this condition, of course, the overload indicator does not indicate an overload condition. If the duty cycle is then decreased to the point where the pulse width circuitry agains begins to operate, the overload indicator again operates.

Any question as to whether the overload indicator is operating properly may easily be resolved by increasing the duty cycle to the point where output pulse amplitude jitter just begins to occur. At this point, the overload indicator should operate. If not, adjust the internal Overload Indicator Adjustment per Instruction Manual calibration instructions.

The adjustment procedure for overload protection circuitry detailed in the Instruction Manual calls for an actual measurement of the average output current passing through the output tubes. This may usually be successfully shortened by simply setting the unit to an 18% pulse width duty cycle (at a repetition rate of 1 mc or less) and setting the internal Overload Adjustment to the point where the output amplitude jitter just begins to occur. Be sure to set the internal Output Stage Bias Adjustments per the procedure on Page 25 of the Manual prior to adjusting overload. If any question remains as correctness of the overload adjustment, follow the detail procedure indicated on Page 26 of the Manual.

# OUTPUT AT GROUND

The positive pulse output of the DATAPULSE Model 102 is specified with baseline nominally around ground, that is, less the +0.5v.

Some applications, such as certain diode tests, require a baseline more near ground. This may be accomplished on the 102 by (1) increasing output bias or (2) using a dc offset.

Both of the above methods have advantages. Use the method best suited to your requirements.

### INCREASING OUTPUT BIAS

This method of adjusting baseline dc level may be accomplished by resetting two internal adjustments.

1. With the polarity switch set on POSITIVE, set the 150v supply to 120v by means of R100 (150v Adj.).
2. Set the repetition rate control to EXT. and observe the dc level at the pulse output jack.
3. Adjust R90 (Pos. Bias) for the required baseline dc level.

Excellent waveform may be obtained with this method; however, since the output tubes are not being driven as firmly (due to increased bias), rise time is increased to approx. 15 nanoseconds and the output amplitude is reduced by approx. 20%. See Figures 1 and 2.

### DC OFFSET VOLTAGE

This method will improve waveform character, but it requires an outside dc source connected as shown in Figure 4. With connections shown in Figure 4 made, place the repetition rate control on EXT., the polarity switch on POSITIVE and observe the dc level at the output jack. Adjust the dc offset voltage until desired baseline dc level is obtained.

Better waveform is obtained than when using the bias shift method, and since the output is driven firmly, negligible increase is noticed in rise time. A slight variation is noticed in amplitude due to loading effects of the offset circuit. The baseline may be placed below ground if desired. The waveform obtained with this method is shown in Figure 3.

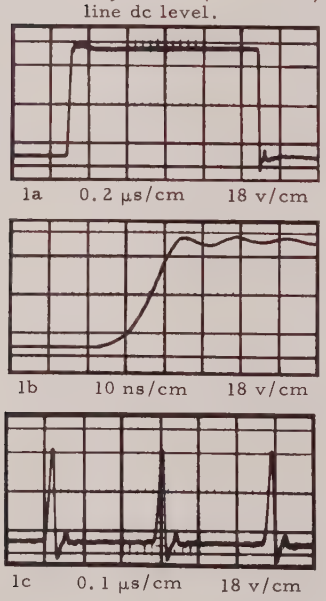



Figure 1. Pos. Pulse with Baseline +50mv Off Ground by Adjusting Output Bias.

(a) 1 µs Wide Pulse at 5 KC
(b) Leading Edge of (1a). Illustrates Rise Time.
(c) Positive Pulse at 3 MC.

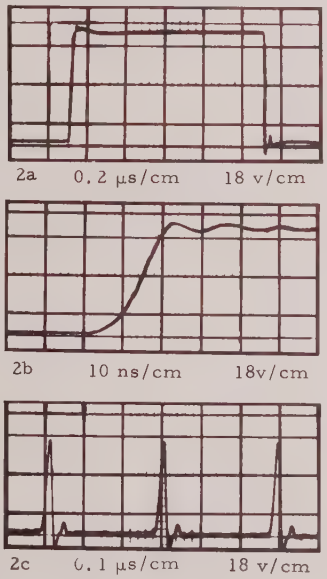



Figure 2. Pos. Pulse with Baseline +10mv Off Ground by Adjusting Output Bias.

(a) 1 µs Wide Pulse at 5 KC
(b) Leading Edge of (2a). Illustrates Rise Time
(c) Positive Pulse at 3 MC

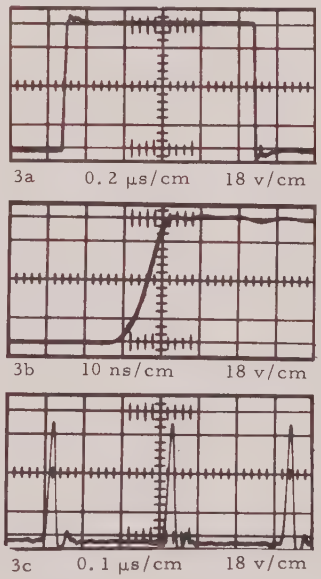



Figure 3. Pos. Pulse with Baseline Less Than 1mv Off Ground by Using DC Offset.

(a) 1 µs Wide Pulse at 5 KC
(b) Leading Edge of (3a). Illustrates Rise Time
(c) Positive Pulse at 3 MC

Photographs were taken from a Tektronix Type 581 Oscilloscope.

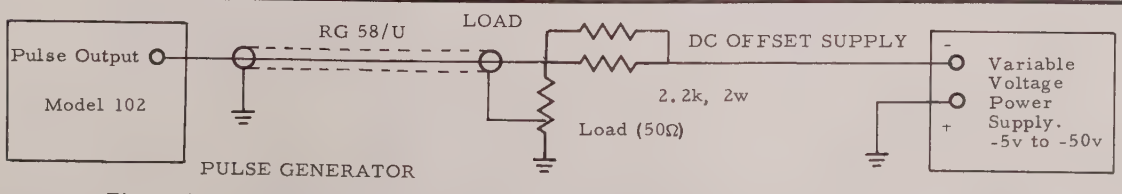



Figure 4. Wiring a DC Offset Supply for Variable Baseline Output of Datapulse Model 102. Baseline may be varied over a range of ±1 volt.

# MODEL 102 ADVANCED PULSE OPERATION

The Model 102 pulse generator can be supplied as a Model 102-S4 providing all features of standard operation, except that delay of the main pulse is variable from 0 to 10,000 μsec. with respect to the sync output (and the sync output is delayed from an external trigger if used by approximately 0.3 μsec.), plus providing pulse advance operation.

In the modified unit, a toggle switch is added to the front panel, labeled "Advance-Delay". In the delay position, the unit functions as a standard Model 102 with minor variations as described above. In the advance position, the instrument generates a main pulse at a fixed position (approximately 0.1 μsec. delay from an external trigger is used) and the delay controls provide the sync output variably delayed with respect to the leading edge of the main pulse over a range of 0 to 10,000 μsec.

This modification should be of particular interest in applications such as delay line testing or pulse network studies, where a controllable parameter pulse is delayed by the device under test, and it is desired to observe the output on a fast oscilloscope sweep by synchronizing the sweep at a controllable delay after generation of the input pulse.

# MISCELLANEOUS MODIFICATION OF MODEL 102

DATAPULSE has recently quoted on Model 102 instruments modified as indicated below for various special applications. This information is passed on to all representatives as an indication of (1) the broad applications of the basic Model 102 (2) our willingness and ability to rapidly quote on minor modifications, and (3) as an indication of the type of modification which can be accomplished with the basic Model 102. The performance detailed is necessarily sketchy, and in some cases results in placing limitations on other specifications of the equipment. Proposal and/or quotation copies are available if anyone requires detailed information on one or more of the items listed.

## ELEVATED BASELINE DC LEVEL:

For application in a satellite system ground support equipment test console, a 9v negative pulse was required from a baseline at a DC level of positive 9v. We quoted on a Model 102 modified by the addition of a cathode follower voltage source which, when mixed with the main pulse output through a coaxial mixer network, provided the required output. An applications bulletin is now in preparation detailing performance and equipment required for the general problem of providing output with baseline either to 0 volts DC or provided at a specified off-ground DC level.

## DELAY GATE OUTPUT AND VARIABLE AMPLITUDE NEGATIVE SYNC

Customer had been utilizing an Electro-Pulse Model 2120A pulse generator in tests of digital modules. The standard Model 102 provided the required outputs, except that the sync output was desired at negative polarity and variable amplitude and an additional output was required with amplitude variable to 4 V positive or negative from a 5,000Ω source and with duration corresponding to delay of the main pulse output. By restricting the maximum repetition rate to 1 mc, the standard Model 102 power supplies were adequate to add a blocking oscillator stage driven by the standard sync output, but providing a variable amplitude negative sync. A second tube was added to provide the variable delay gate output required, driven from an existing waveform in the delay circuit.

## TWIN PULSE OPERATION

Where requirements exist for two identical pulses in each cycle, variable in separation, the Model 102 may be modified by the addition of required circuitry and a front panel toggle switch which selects either standard or twin pulse operation. When operating in the twin pulse mode, the standard main pulse output is furnished in the normal fashion, in addition to which the main pulse width and output circuitry is triggered at sync pulse time. This provides the regular main pulse output, and on the same line, an identical pulse (with same rise time, polarity, and amplitude) on the main pulse output line with leading edge approximately 0.1 μsec. following the sync output. Separation between the pulses (trailing edge to leading edge) cannot be set to less than approximately 50% of the pulse width setting or 0.5 μsec., whichever is greater. Note that operation in the twin pulse mode is effectively limited to a basic repetition rate of somewhat above 1 mc. A standard model number 102-S3 has been assigned to an instrument modified in this manner. In this connection, it should be noted that this modification provides an instrument essentially equivalent to the Electro-Pulse Model 3450D, in which this feature is offered as standard performance.

# PULSE SHOCK TESTING
# WITH MODEL 102 PULSE GENERATOR

Brimberg Associates, Washington, D. C. has recently sold a Model 102 Pulse Generator for application in conjunction with environmental shock testing. The customer was Texaco Experimental Station, Richmond, Virginia.

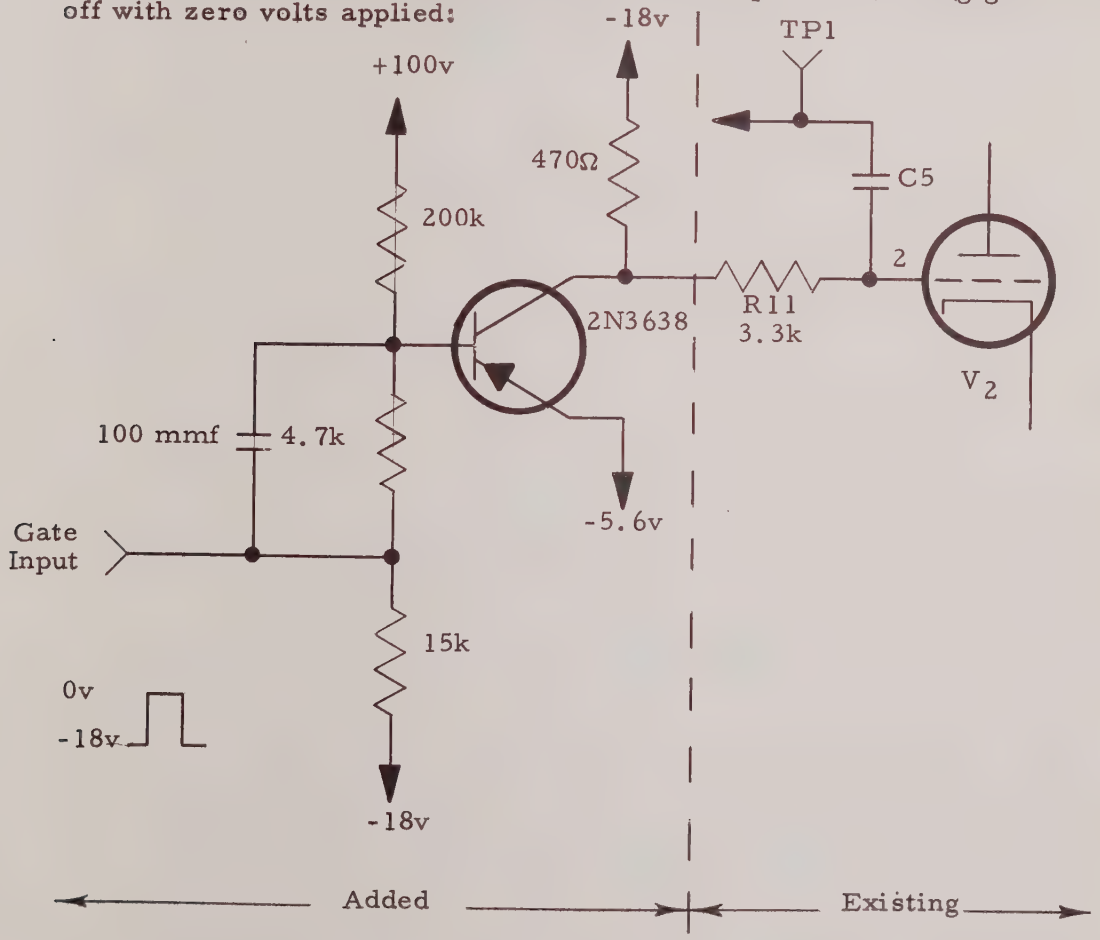
This most interesting application involves utilizing the pulse output of the Model 102 to drive a shake table power driver, thereby providing controlled duration and acceleration shocks.

The equipment is used at Texaco in conjunction with a Ling Model 219, 500 forcepound unit, frequency response DC to 6000 CPS, maximum acceleration 86 G's. At the same time the DATAPULSE unit was purchased, Texaco also purchased an Avco shock tester costing on the order of $7,000. They have since found that some 50% of their shock test work is accomplished with the Model 102 set-up. The advantages here are obvious, with shock testing run at the same time and on the same set-up as vibration testing, while freeing shock testing equipment for heavier jobs beyond the capability of the Model 102 product.

This application of the DATAPULSE Model 102 Pulse Generator should be of significant interest to all environmental test laboratories.

# MODEL 102 MODIFICATION FOR GATED OPERATION

In certain test applications it is desirable to place the output of a pulse generator under control of a gate signal. Addition of the following circuitry to the standard Model 102 Pulse Generator allows the instrument output to occur in the normal fashion with no connection or less than 18v presented to the added Gate Input Jack, being gated off with zero volts applied:



**APPLICATIONS BULLETIN**
**NO. 102-11**

# MODEL 102
# RISE TIME AND WAVEFORM SPECIFICATIONS

The current Model 102 specification states minimum rise time as "nominally 10 ns" without specifying overshoot at this rise time and further states "overshoot less than 15 ns in duration is less than 4 percent of nominal amplitude at rise times of 13 ns and greater, at less than 30 db attenuation".

This bulletin is issued (1) to amend the minimum rise time for 4 percent overshoot to 15 ns, effective immediately, and (2) to further define and clarify these rise time specifications.

The majority of units achieve the 13 ns specification without rework in production test. Those units do not often require extensive rework to bring rise time within 13 ns. Value engineering considerations suggest that the value added by achieving 13 ns rather than 15 ns minimum rise time with less than 4 percent overshoot is simply not worth the added cost. In this respect it should be noted that (1) the highest frequency harmonic in a 15 ns rise pulse is approximately 23.4 mc vs 27 mc at 13 ns rise, (2) the majority of Model 102 applications are with circuits or components whose bandpass is well below either of these frequencies (the widely used Tektronix 540 series oscilloscopes, with plug-in and probe, have only a 15 to 20 mc bandpass), and (3) a 15 ns specification is typical of major competition for this unit.

Current production test procedures for verification of rise time and overshoot are now as follows (measurements made with Tektronix 561, 567, or 661 sampling oscilloscope):

1. Rise time on both pos. and neg. output, at full amplitude and with rise time control at minimum, must be less than 11 ns. Typical units show 9.5 to 10.5 ns on pos. and 6 to 8 ns on neg. No measurement is made of overshoot at minimum rise time, but typical units show on the order of 10 percent on pos. and 6 percent on neg.

2. With a full amplitude pos. pulse of approximately 0.5 usec. duration, the rise time control is increased until a 15 ns rise time is observed; overshoot must then be less than 4 percent of the pulse amplitude as measured on the flat top just in front of the trailing edge. The same procedure is repeated for the neg. pulse.

SERVICE BULLETIN
NO. 102-3

# MODIFICATION OF MODEL 102
# FOR ULTRA VERNIER RESOLUTION ON 0.5 μs DELAY RANGE

The standard Model 102 Pulse Generator, with its 1-2-5 series delay ranges, offers a resolution of less than 3% delay change per 5° rotation of the delay vernier control to satisfy all but the most critical requirements. Certain tests in the range of 150 to 500 nanosec delay, however, are more easily made with increased resolution. This bulletin details a modification to the standard Model 102 to provide essentially nanosecond resolution on the 0.5μsec delay range, as follows:

1. Remove R307 (150 ohm 5%) in shunt with R303A (500 ohm front section of potentiometer mounted on delay range switch).

2. Drill a 0.390 dia hole 1-9/16" below the Pulse Delay Switch horizontal axis on the same vertical axis.

3. Solder a white wire approximately 6 inches long to the counter clockwise terminal of a Chicago Telephone Supply Company Series VA45-6236 Potentiometer (150 ohm, 10 turn).

4. Solder a black wire approximately 6 inches long to the clockwise terminal of the potentiometer connecting the clockwise terminal to the arm in the process.

5. Install the potentiometer in the 0.390 dia hole previously drilled.

6. Solder the white wire to the counterclockwise terminal of R303A.

7. Solder the black wire to the clockwise terminal of R303A.

8. If desired, the added control may be labelled "0.5μs Delay Range Ultra-Vernier", with a CCW arrow labelled "Decrease Delay".

9. Indicate the above change on the instruction manual pulse delay switch schematic diagram (drawing D40000-002). Add to page 23 of the manual after the heading Pulse Delay Calibration " - Vernier and Ultra-Vernier fully CW". Add on page 31 (Verification of Specifications), at end of first line in para. 1 under Pulse Delay " - Ultra-Vernier fully CW".

The ultra-vernier control may now be utilized as a fine control, on the 0.5μsec delay range, to control delay with greatly increased resolution.

# ADDENDA AND ERRATA

Datapulse Model 102
3 MC Pulse Generator

| E.O. NO. | EFFECTIVE DATE | DWG. NO. | CHANGE |
|---|---|---|---|
| 387 | 11-15-63 | D40000-003C | Schematic: Pulse Width Switch. R403B=2 MEG (was 1.5 MEG.). |
| 430 | 2-4-64 | D40000-002C<br>D37000-006C | Pulse Delay Switch. R-305*=62 ohms (was 60 ohms). |
| | | D40000-003C<br>D37000-007C | Pulse Width Switch. R405*=62 ohms (was 68 ohms). |
| | | | NOTE: *May be changed over a range of 56 ohms to 75 ohms for calibration. |
| 815 | 1-11-66 | H40000-000D<br>D37000-000B | Over-all schematic 3 MC Pulse Generator Assembly. Attenuator and Output Amplifier.<br>1. Add a 0.01 μF, 500V ceramic disc capacitor in parallel with series combination of ferrite bead and C-40 capacitor (20 μF, 250V).<br>2. Delete R65, 22 ohm resistor and replace with sleeved wire jumper. |
| 847A | 2-21-66 | H40000-000D | Schematic - Pulse Generator<br>1. Change R44, 45, 48, 49, 52 and 53 from 470 ohms 2 W, to 150 ohms, 2 W.<br>2. Add a DP16-0 diode between R44, 45, 48, 49, 52 and 53 and Grid. Cathode towards next stage. Respective ref. des. CR25 through 30.<br>3. Change ref. des. block "Last Used" CR30. |
| | | L/M37000-002 "E" | Circuit Board Assembly<br>1. Change Item 40, Qt'y 7. Add ref. des. R45, 48, 49, 52, 52. Was Qt'y 1.<br>2. Change Item 43, Qt'y 3. Delete ref. des. R44, 45, 48, 49, 52, 53. Was Qt'y 9.<br>3. Change Item 77, Qt'y. 10. Add ref. des. CR25 through 30. Was Qt'y 4. |
| | | H40000-000D | Schematic - Pulse Generator<br>Change R56 to 470 ohms, 2 W. Was 680 ohms, 2 W. |
| | | L/M37000-002 | 1. Change Item 43, Qt'y 4. Add ref. des. R56. Was Qt'y 3.<br>2. Change Item 44, Qt'y 4. Delete ref. des. R56. Qt'y was 2. |
| 871 | 3-23-66 | H40000-000D | Schematic - Pulse Generator<br>1. Add Note 8. Asterisk indicates factory adjusted value.<br>2. Add an asterisk (*) after R55. |
| 890 | 4-14-66 | H40000-000D | Schematic - Pulse Generator<br>Delete C71 and 72. |
| 2069 | 8-3-66 | H40000-000D | Schematic - Pulse Generator<br>Change CR24, Diode, DP16-0, P/N 12164-000 to 1N34A, P/N 121-4-003. |
| 2021 | 8-26-66 | Transistor Equiv. | SM 1330, P/N 12685-004 is an acceptable substitute for DP63-6, P/N 22635-006. |
| 2081 | 8-26-66 | Transistor Substitution | 2N2102, P/N 12685-005 may be used in lieu of 2N2270, P/N 12695-001. |

# ADDENDA AND ERRATA



| E. O. NO. | EFFECTIVE DATE | DWG. NO. | CHANGE |
|---|---|---|---|
| 2130 | 11-2-66 | H40000-000 | Schematic<br>Change V21, 23 and 27 vacuum tube, P/N 12001-001 from designation "6AS7GA" to No. 6080. |
| 847B | 12-30-66 | H40000-000D | Add to Note 8: "May or may not be present."<br>2. Add an asterisk after CR25-30 diodes. |
| 2200 A | 2-6-67 | H40000-000D | Schematic<br>1. Add an asterisk (*) after R44, 45, 48, 49, 52, 53, 55, 56, and 65.<br>2. Add a capacitor 27 pF, P/N 11017-270 and assign ref. des. C71 with an asterisk between TP6 and ground.<br>3. Change R44, 48, and 52 from 150Ω, 2 W, P/N 10023-151 to 220Ω, 2 W, P/N 10023-391.<br>4. Change R56 from 470Ω, 2 W, P/N 10023-681 to 390Ω, 2 W, P/N 10023-391. |
| 2359 | 11-18-67 | SB 1-65 | NPN Transistor equivalent: RCA 38880 is an acceptable equivalent for RCA 40250. |
| 2322 | 7-17-68 | Manual | Para. 1.7.4:Change from<br>"...Overshoot (less than 15ns in duration) is less than 4% of nominal amplitude at rise times of 15ns and greater..."<br>to<br>"...Overshoot (less than 15ns in duration) is less than 4% of MAXIMUM amplitude at rise times of 15ns and greater..." |
| 2509A<br>(2509 issued 7-11-68) | 11-11-68 | Manual | Accuracy Specification.<br>In "Jitter & Accuracy" paragraphs DELETE "Accuracy" title and statement. |

# ADDENDA AND ERRATA



| E. O. NO. | EFFECTIVE DATE | DWG. NO. | CHANGE |
|---|---|---|---|
| 2654 | 1-6-69 | 40000-000 | Schematic - Pulse Generator<br>1. Add Note 8: (*) asterisk indicates factory adjusted value, may or may not be present.<br>2. Add an (*) asterisk to C12.<br>3. Add a .01μF, (C76), ceramic disc capacitor P/N 11247-103 from the junction of L3 and the anode of CR6 to Grd. (Pin 5 of V7).<br>4. Change R18 from 47 ohm, 1/2W, P/N 11011-470 to 150 ohm, 1/2W, P/N 10011-151. |
| 2654A | 1-6-69 | 40000-000 | "A" changes item 4 above - Change R18 from 47 ohm, 1/2W, P/N 10021-470 to 150 ohm, 1/2W, P/N 10021-151. |
| 2971 | 4-29-70 | 40000-000 | Change DS2 from NE51H to NE51 |
| 3065 | 8-5-70 | Manual | Parts List--Paragraph 5.5 Miscellaneous--Page 5-9<br>Change DL1 from 0.09 μs PCA DL500B--0.09--5079 DP P/N 14200-001 to 0.01 μs Vidcor A1717 DL500B--0.1--5361 DP P/N 14200-000. |

# WARRANTY

The Datapulse Division, Systron-Donner Corporation (hereinafter referred to as Datapulse) warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this Warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to making good at our factory any part or parts thereof except tubes, transistors, fuses or batteries which shall, within one year after making delivery to the original purchaser, be returned to us with transportation charges prepaid, and which our examination shall disclose to our satisfaction to have been thus defective.

Instruments returned under this Warranty will not be accepted at the Datapulse plant without prior authorization by a Datapulse representative or by the service manager of Datapulse.

Datapulse reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This Warranty is expressly in lieu of all other obligations or liabilities on the part of Datapulse and Datapulse neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of Datapulse instruments.

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